BREAD MARKETS:

A SYSTEMS ANALYSIS OF INTERFIRM BEHAVIOR

By

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SUMMARY

This study developed a model of a bakery market to appraise the relative efficiencies of alternative methods of distributing bread. Particular emphasis was placed on simplicity in formulation, possibility of estimating parameters from available data, and keeping future data gathering costs low.

The model was validated against behavior of wholesale bakers in 1960 and 1964. Analysis of three experiments shows the model to be a useful tool for measuring and appraising the relative efficiencies of alternative distribution systems and pricing policies.

Market demand elasticities for bread were estimated from government and industry data. The estimated price elasticity was -0.372, and the income elasticity was +0.086. This means that a 10 percent increase in bread prices would cause a 3.7 percent decrease in per capita demand. A 10 percent increase in per capita disposable income would cause only a 0.9 percent increase in per capita demand.

Rigidities in labeling and distribution practices are largely institutional. Bakers cannot quickly alter the high proportion of bread wrapped in their own label and distributed by driver-salespersons because of contractual arrangements with labor unions. A principal factor in forestalling private label and drop-stop and dock-pickup deliveries is the increasing economic control of chain stores. Excess capacity in the wholesale baking industry may make it relatively easy for the chain store to obtain another contract. But without a contract, a baker may not have an outlet for a substantial part of the desired production.

The reliance on own brand labeling and driver-salesperson wholesale delivery is shown in the model. More than 80 percent of a firm's supply was allocated to its primary label or outlet. The other factors of the decision subsystems show that the model is responsive to changes in the relative profits by type of outlet. But the model assumes that prior institutional or contractual

conditions would restrict the degree to which a firm may change its pricing policy or cost structure. For example, in the simulation model if a firm did not use drop stop or dock pickup in its present practice, these markets were not accessible to it in the simulated runs. Such restrictions could be relaxed in future experiments.

Even though chain stores cannot produce bread any more cheaply than wholesale bakers, they apparently have an economic advantage in terms of distribution costs. So, the performance in the baking industry might improve appreciably if bakers can alter their labor union contractual arrangements and if economically feasible contracts can be arranged between chain stores and wholesale bakers which involve price, diversification of contracts, and terms of negotiation.

This model could be used to determine quantitative answers to important questions. What percentage of output might be wrapped as private label? What percentage of output might be distributed as drop stop or as dock pickup? What might happen to per unit profits if bakers more freely switched labels and distribution outlets? The answers to these questions could aid negotiation of contracts between labor unions and bakers as well as between bakers and chain stores.

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by Theodore F. Moriak and Samuel H. Logan[1/]

INTRODUCTION

The wholesale baking industry has been repeatedly challenged to find means to increase its efficiency. The widening spread between bread prices and wheat prices in the twenties, for example, was a major reason for developing reports on agricultural marketing margins by the U.S. Department of Agriculture (44).[2/] Although many economic studies have been made of this industry, the challenge of building a more efficient industry remains.[3/] In the sixties, the industry experienced low and decreasing profit rates at a time when the wholesale and retail prices of bread increased substantially. The profit rate declined 27 percent between 1960 and 1964 (27, p. 106). By 1968, the retail price of bread was 170 percent higher than for 1947-49 (44, p. 8) and had risen three times

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1/ Moriak was an Agricultural Economist for the Economic Research Service when this report was written and is now an Economist for the Office of Management and Finance. Logan is Professor of Agricultural Economics at the University of California at Davis.

2/ Underscored numbers in parentheses refer to references listed at the end of the report.

3/ For example, before 1960 studies were made of stale bread losses (8); relationships among wheat, flour, and bread prices (22); costs of distribution (19, 43); technological innovations in the baking industry (31); and structure, conduct, and performance in the baking industry (38, 39).

The analysis in this report was made before the price disturbances of the seventies. The recent rise in bread prices emphasizes once again the need for finding ways of improving efficiency.

as fast as the average price of other food products. In fact, between World War II and the mid-sixties, bread prices made up nearly a fifth of the total increase in the average price of food consumed in the home (11, p. 1).

The goal of this study was to develop a systems model of the baking industry useful in estimating the economic impacts of alternative bread distribution systems. Although the parameters in the model would need updating to cover events of the seventies, the basic framework of the software package could be used to analyze effects on bread prices and firm profit rates resulting from the reallocation of resources in bread distribution, both intrafirm and intraindustry, while taking into consideration coordination of interfirm behavior. Coordination may involve incorporating new technology and market rules, since each may require an alteration of the economic environment in the sense of an "understanding" among firms before any changes are implemented.

The systems model of the baking industry includes behavioral relationships of industry pricing, output, distribution, and net revenue for firms within a market. An analysis of the effects on profit rates or prices because of reallocated resources in bread distribution provides quantitative measures of gains obtainable by producers and consumers. But such reallocations can be impeded in the market. Costs of implementing a different system are affected by institutional restraints on the structure, conduct, and performance of the industry, for example, labor restrictions and antitrust legislation. Although these obstacles cannot be handled in a quantitative sense, they will be dealt with qualitatively. Such changes in the environment may affect pricing policies, decisions about quantities produced, and types of innovations adopted which in turn affect costs of ingredients, manufacturing, administration, and distribution.

To construct a decision-oriented model, estimates must be made of--

- Behavioral parameters in and among baking firms with respect to decisions on (1) pricing, (2) quantity produced, (3) types of labeling,

(4) types of distribution outlets, (5) production techniques, (6) methods of ingredient handling, and (7) the level of advertising;

- Parameters of a firm's total cost functions; and
- Parameters of consumer demand for the industry's commodity, and a firm's product.

This quantitative economic information was integrated into a systems model. Essentially, the first two steps represented the supply component, the last the demand component. Characteristics of behavior are intermingled within firms, between firms, and between industry and consumers. The integration of the estimated mathematical relationships into a systems model provides the tool of analysis. A computer software package was written where behavioral and cost parameters are considered as input. The general objective can be reached by experimenting with the model and analyzing the economic effects of alternative behavioral patterns related to firms' selection of distribution outlets and changes in pricing policies.

General Description of the Baking Industry

The 1967 production of bread and bread-type rolls totaled 14.4 billion pounds and had a value of $2.8 billion (45). This represented 80 percent of the industry's total production and 65 percent of its sales.[4/] Since distribution and related expenses represent more than 50 percent of the value of

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4/ Bread and bread-type rolls include hearth breads, Italian, French, whole and cracked wheat, rye, pumpernickel, raisin and other specialty breads, hamburger buns, weiner buns, Kaiser rolls, Parkerhouse rolls, English muffins, and others. except for any disposed of in frozen form. The total production includes such items as sweet yeast breads, soft cakes, pies (except frozen), pastries, and doughnuts.

production, an increase in distribution efficiency can have a significant impact on profit and price performance. Although the baking industry produces many types of products, this study focuses on the market for bread and bread-type rolls.

The number of firms in the industry has been declining. The number dropped from about 6,800 bakeries in 1947 to about 4,000 in 1967 (45)--an average attrition rate of 140 bakeries each year. Also, only 261 wholesale bakery plants with an average capacity of 800,000 pounds per week were needed in 1963 to produce all of the bread demanded in the country.[5/] At this rate of production, a single firm could supply all the bread for about 530,000 persons.

The three types of bread producers are wholesale bakers, grocery chain-store bakers, and retail bakers. These categories represented 80.8 percent, 11.6 percent, and 7.6 percent of the 1968 national bread market sales, respectively (3, p. 44). Wholesale bakers consisted of nine large multistate corporations, three large cooperatives whose members were independent bakers, and many other independent bakers.[6/]

Multistate corporation wholesale bakers ran 340 plants that produced about 40 percent of the bread in 1965 (27, p. 50). Since these bakers operated in many markets, they could take advantage of large scale efficiencies in production, distribution, and advertising.

5/ In 1965, several plants had double this weekly capacity (27, p. 55).

6/ The multistate corporations were Continental Baking Company, Inc.; American Bakeries Company; Campbell Taggart Associated Bakeries, Inc.; General Baking Company; Ward Baking Company; Interstate Bakeries Corporation; National Biscuit Company; Southern Bakeries Company; and C. J. Patterson Company. The cooperative associations were Quality Bakers of America, W. E. Long Company, and American Bakers Cooperatives.

In 1965, 261 cooperative bakers produced about 24 percent of the bread in the United States (27, p. 50). A baker belonging to a cooperative generally had one plant and cooperated with other bakers on collecting cost and revenue data, conducting advertising campaigns, and negotiating for flour and bread distribution contracts.

An independent baker (one of about 3,000) usually had one plant and operated independently of all other bakers. Only 100 of these firms had individual sales over $1 million, but practically every plant of the cooperatives and multistate corporations exceeded $1 million in sales (27, p. 51).

Retail bakers have integrated vertically by marketing bread through chains of bake shops. There were 289 such bakeries in 1963, but they represented only a small part of industry production (45).

Some chain stores have integrated vertically by producing bread. Most of their products are made in centralized plants and shipped to their retail stores. Instore bakeries produce the rest.

In any of these structural groupings, an individual baking firm coordinates several decision areas. Since the economic aspects of changing distribution systems is of primary concern in this study, these decisions are explored in more depth.

Wholesale bakers market their bread in several ways. Rack service to retail grocery stores has been the predominant method and represented more than 80 percent of revenue in 1960, after making allowances for sales deductions, and 75 percent in 1964 (27, pp. 82-85). The driver-salespersons not only make deliveries but also set up displays, return stale bread, collect money, extend credit, and so forth. On other routes, they make sales from house to house. This method of marketing has been declining in importance and accounted for less than 5 percent of sales in 1964. Warehouse and drop-stop deliveries to

retail grocers, restaurants, hotels, and institutions increased by 50 percent from 1960 to 1964. Sales at the bakers' dock also increased appreciably during that period.

Wholesale bakers also wrap bread in different types of labels. Their own brand is the main label and represented more than 98 percent of revenues in 1960 and 94 percent in 1964 (27, pp. 76-77). This brand is usually advertised through various communication media as well as at the point of sale. Own brand is usually distributed by driver-salespersons, and the other private labels are generally reserved for the drop-stop and dock-pickup marketing channels. In such a situation, a large chain store that wants its own private label contracts production with a wholesale baker.

Rising prices are often blamed on the industry's lack of price competition. During the period 1958-68, nine price conspiracy charges were brought by the U.S. Department of Justice and the Federal Trade Commission (FTC) against leading wholesale bakers and some grocery chains.[7/] Charges of monopolistic pricing were investigated in 1959 by the U.S. Senate Subcommittee on Monopoly and Antitrust. Their investigative hearings (53) revealed that the sales concentration (percentage of the market total) had increased for the eight largest multistate corporation wholesale bakers in the preceding 4 years.[8/] According to the U.S. Senate's report (54, p. 179), this was accomplished by these nationally

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7/ Cases included most regions of the country as shown by the conspiracy charges in Washington, Nevada, Oklahoma, Texas, Kansas, Missouri, Tennessee, Michigan, Ohio, New Jersey, Florida, and Georgia.

8/ A later study (46, p. 7) of actual data showed that the eight largest companies increased their share, or concentration ratio, to 5.5 percent of all sales.

oriented companies primarily through marketing practices in local market areas--practices that virtually eliminated price competition in any market dominated by a major company.[9/]

Reasons for bread price rises were again investigated in 1966. This time the U.S. House of Representatives Subcommittee on Wheat reported that although bread prices had risen 10 percent earlier in the year, it was unable to ". . . find any segment of the industry making unconscionable profits . . ." (52, p. 12). But it showed that wholesale bakers and labor unions would benefit from modernizing their delivery systems to reduce per unit distribution costs.[10/]

9/ The large firms increase their volume but increased total costs more than proportionately. These practices included: (1) providing free bread and free fixtures to grocery stores not already on their routes, (2) overstocking some of the stores with the belief that the consumer considers the largest display of bread on the shelf as being the most popular brand and hence the best buy, (3) selectively granting grocers discounts and allowances, (4) providing cash for display space or a "preferred rack position", (5) introducing a secondary load sold under a different label and made with a formula that used no fermentation process to yield a greater baked weight from given inputs, and (6) meeting the price per loaf but selling a larger loaf (54, pp. 66-96).

10/ A loaf of bread that cost 11 cents at the baker's dock in 1964 sold for about 20 cents at the retail store. Typically, five or six bakery trucks representing different wholesale bakeries delivered to a supermarket each day. Then, these driver-salespersons made return visits to stock shelves and remove stale items. This duplication of service contributes to high selling and distribution costs (27, p. 107).

The industry's economic environment, in which bakers attempt to maintain their relative market shares of a relatively constant per capita demand for bread, causes escalating per unit costs of promotion and advertising. Wholesale bakers often attempt to hold a consumer's brand loyalty and to keep control of retail outlets by advertising and by other such promotional activities as in-store services of stocking, display, and so forth, that are performed by the driver-salesperson. Bakers see this as the only way to maintain or improve profits (56, p. 167). The nonprice competitive responses by other bakers--to retain their respective market shares--are offsetting and merely result in rising per unit advertising and promotion expenses and falling profit rates for the industry as a whole. In fact, advertising, promotion, and related expenses made up 16.7 percent of the baker-wholesaler spread in 1960, and they increased to 19.1 percent in 1964 (27, pp. 128-131).

Increasing per unit selling and distribution costs are due in part to economic rigidities in the driver-salesperson distribution system which make the industry unresponsive to changes in grocery retailing. This system was instituted to service small grocery stores with daily small-lot deliveries of bread. But now, the increased concentration of retailers' purchases makes the driver-salesperson distribution method inefficient. For example, the selling function is shifting from driver-salespersons to direct negotiation between bakers and grocers. Nevertheless, driver-salespersons have retained their conventional selling commission of 7 percent or more of the wholesale price on all bakery products distributed in their territory (27, p. 109). Such a delivery system has become less efficient because of excessive duplication of services and a

high return rate for stale bread (11, pp. 27-31).[11/] Since much of a driver-salesperson's activity is related to a bakery's nonprice competitive practices and since such services can be effectively counteracted or duplicated by other bakers, per unit selling and distributing costs for all bakers are frequently increased with no change in market shares.

Increasing prices to offset falling profit rates is an interfirm problem because actions on prices and methods of distributing bread by one firm may affect performance of other firms. These studies indicate that performance of the industry as a whole can be improved, presumably if firms adjust their distributing systems and pricing policies.

Intermarket Behavior

Economic analyses of the U.S. baking industry have often focused on the entire national "bread market." These analyses have indicated little concentration of production in the larger firms. But analyses of more fractionated markets (regional, State, or city delineation) showed that concentration ratios generally increased as size of market decreased.[12/]

11/ Data on a group of independent wholesale bakers showed that selling and distributing costs increased by 68 percent from 1956-65, but manufacturing costs increased only 17 percent and ingredient costs remained relatively constant. A similar record was maintained for the preceding decade (11, p. 28). In an economic engineering study of cost functions for alternative distribution systems (23), 25 percent of the driver-salesperson's stops were devoted to such callbacks as checking on the display and supply of bread.

12/ For city markets, the range of concentration for the top four bakeries was 39 percent in Minneapolis to 92 percent in Memphis for 1963. In

(Footnote continued on page 10)

Given current transportation technology and the perishable nature of bread, the United States is a complex linked set of bread markets (51, 53). There seems to be invisible boundaries around some of the larger markets. For instance, the Washington, D.C., and Baltimore markets, which are only 30 miles apart, apparently lack any intercity production and distribution. An analysis of such market situations by one group concluded that the United States is made up of, " . . . 80-100 relatively small and semi-independent bread markets . . ." (2, p. 73).

Intramarket Behavior

The typical bakery market is a differentiated bilateral oligopoly (56, pp. 163-164). Wholesale baking firms make up one side of the bilateral oligopoly and retail grocers the other. Virtually all bakery markets have an oligopolistic core of wholesale baking companies surrounded by a fringe of smaller bakers. Intermingled in the market fringe are small retail bake shops. On the other side of the bilateral oligopoly, retail grocery markets have a concentrated core of supermarket grocers and a fringe of smaller stores. The two concentrated cores of market power--chain supermarkets and wholesale bakers--negotiate terms under which the differentiated commodity (bread) is sold, thus forming a differentiated bilateral oligopoly.13/

(Footnote 12 continued)

States, it was 25 percent in New York to 96 percent in Delaware for 1958. For regions, it was 23 percent in the Middle and South Atlantic to 41 percent in the Pacific for 1958, and for the national market it was 22 percent for 1958 (27, pp. 52-54).

13/ Terms of negotiation include allocation of shelf space, position on the shelf, and consignment rate.

Retaining control of the bread all the way to the consumer is a source of market power for wholesale bakers. The extent of a wholesaler's market power is based on the baker's market share and on the success in maintaining or improving it.[14/] Wholesaler's advertised brands lead to brand loyalty and, therefore, help to maintain a firm's market share. Callbacks or instore services of restocking, straightening displays, and so forth also serve to preserve a wholesaler's market share and to maintain a quality image with consumers.

The supermarket chains (corporate, cooperative, and voluntary) can exert market power in two ways. First, most larger chains have enough bread sales to bake their own bread (56, p. 165). This situation concerns wholesale bakers, because private label bread which is sold at lower traffic-building prices drastically affects demand for their own advertised brands. An examination of per unit costs indicated that supermarkets cannot produce bread any cheaper than wholesale bakers; but their total per-unit costs are lower because of little advertising, large drop deliveries, and low stale losses (11). These lower per unit costs may explain in part why supermarket brands can be sold for 2 to 5 cents per pound less than the prevailing prices of wholesale brands.

Second, the implicit threat that supermarkets can produce their own bread has forced some wholesale bakers to undertake private label production contracts with chain supermarkets. Independent wholesale bakers increased the proportion of their private label production from 12 percent in 1960 to 20 percent in 1964. Cooperative and multistate corporation wholesale bakers increased their proportions from 2.5 to 7.6 percent and from 0.7 to 3.7 percent, respectively (27,

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14/ If price leadership remains with the same firm over time, it may have more than its share of market power. But price leadership may fluctuate among firms, so the price leader in any period likely will not have disproportional market power.

pp. 76-77). Producing private label bread means that wholesale bakers lose control of their bread at the retail outlet, but it does permit them to stay in business.

MODELS OF INTERFIRM BEHAVIOR

Various methods have been used in previous analyses of oligopolistic behavior (58, 15, 35). Most of these models were either entirely theoretical or did not include interfirm behavioral characteristics.

One simulation model of oligopolistic behavior with learning characteristics was particularly useful in this study (7).[15/] In this model, each firm makes decisions on price, output, and selling costs from information on its goals, costs, and competitive behavior.

Price was a decision variable, not simply the result of market mechanisms. In setting price, each firm used information on its average cost of manufacture; effects of past price changes; performance of its profit, market share, and sales goals; and long-run price behavior of its competitors.

Sometimes the sales goal conflicted with the profit goal. This arose from pressure by the sales staff to lower price and increase sales, an action which reduced profits and was not permissible.

The model included a search program to find alternative solutions to price cutting. These alternatives included lowering the inventory ceiling, applying pressure on sales for improved profit performance, and increasing sales promotion costs.

Production was set in response to sales and inventory positions, subject to restraints on maximum changes in production. Sales were forecast as a

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15/ Naylor and others (28) discuss this model along with many other analyses of economic systems in demonstrating techniques of computer simulation.

function of lagged sales. Inventory could increase so long as it was between its moving ceiling and base. The production ceiling and base were constrained to the maximum and minimum production in preceding periods.

Selling expenditures were affected by the marketing strategy. These strategies were influenced by the desire to maintain a firm's level of sales, market share, and relative price position. Such information was translated into two variables. The first, "sales effectiveness pressure", was an aggregate surrogate for decisions that influence efficiencies of various sales programs. The other, "sales promotion percentage", related the percentage of total revenue used for sales promotion. Both variables directly affected sales; the latter was a component of costs as well.

Consumer behavior was described by a market demand function, and a market share concept was used to allocate it to individual firms. While firms collectively affected the level of market demand, actions of an individual firm relative to those of all other firms helped determine its market share. The final test of the firm's decisions came when its market share was determined, because this greatly affected revenues.

The model, however, lacked complete development of cost functions. Only one equation, which was represented as per unit cost times quantity, estimated total cost. Although this model reflected many decisions affecting revenues, by including decisions about costs, the model would have been more realistic.

Modeling Bakery Markets

Like the Cohen and others model, this analysis assumes as n-firm oligopolistic market in which each of the firms is similar in the sense that each makes the same decisions in much the same way. Firms are different in terms of structural variables and decision parameters.

A firm's goals provide the foundation for the decision-making process and dictate the nature of the decisions made by management. In the model developed in this study, two basic goals were postulated (1) a satisfactory profit level, and (2) improved production or maintenance of market share.[16/]

Given these goals, each firm makes four basic decisions with respect to the following:

1. price charged for the firm's product;[17/]
2. amount of output produced, which is based on an estimate of market demand;
3. quantities of production associated with types of:
   (a) bread labeling--bakers' own wholesale label and private label of other wholesalers or supermarkets;
   (b) distribution outlets--rack service at the store (driver-salesperson wholesale), home delivery (driver-salesperson home service), drop delivered to the store (drop stop), and nondelivered (dock pickup);
   (c) production techniques--conventional batch type or continuous mix; and
   (d) ingredient handling--bags and bulk; and
4. level of advertising.

This model exhibits instantaneous feedback and adaptation, but the Cohen and others' model exhibited a gradual process of learning. Thus, this model will not generate time paths of outcomes on price, innovation decisions, or

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16/ For a discussion of multiple goals in decision making, see (12).

17/ Price is viewed as a decision variable, not simply as the result of market mechanisms.

costs. But it is used to analyze the impacts of alternative distribution systems and market rules for specific time periods. The means and variances of the output variables provide information to firms which can be used to help determine whether or not individually or collectively they want to promote change in the economic environment of their industry.

The decision processes for the retail multiunit bakers are not considered in this model. Wholesalers do not consider them as serious competitors. Moreover, studies of structure, conduct, and performance of the baking industry have treated retail bakers summarily (39, 42, 55).

The decision processes of the chain store baker part of the industry are included in the model. But several difficulties arose in developing their decision processes in detail. Previous studies of the baking industry indicated how chain store bakers operate in relation to wholesale bakers, but they did not generate data for comparing the efficiencies of production and distribution (42, 55).[18/] This would be a major undertaking in itself and is beyond the scope of this study. Chain store baker decision processes, revenues, and cost relationships were approximated by using information about chain operations that was given in other structure, conduct, and performance studies and by using selected parameters associated with other wholesale bakers for whom data are available.

Operation of the Model

The flow chart in figure 1 shows the decision framework for the bakery market system. Appendix A summarizes the components of the system and portrays

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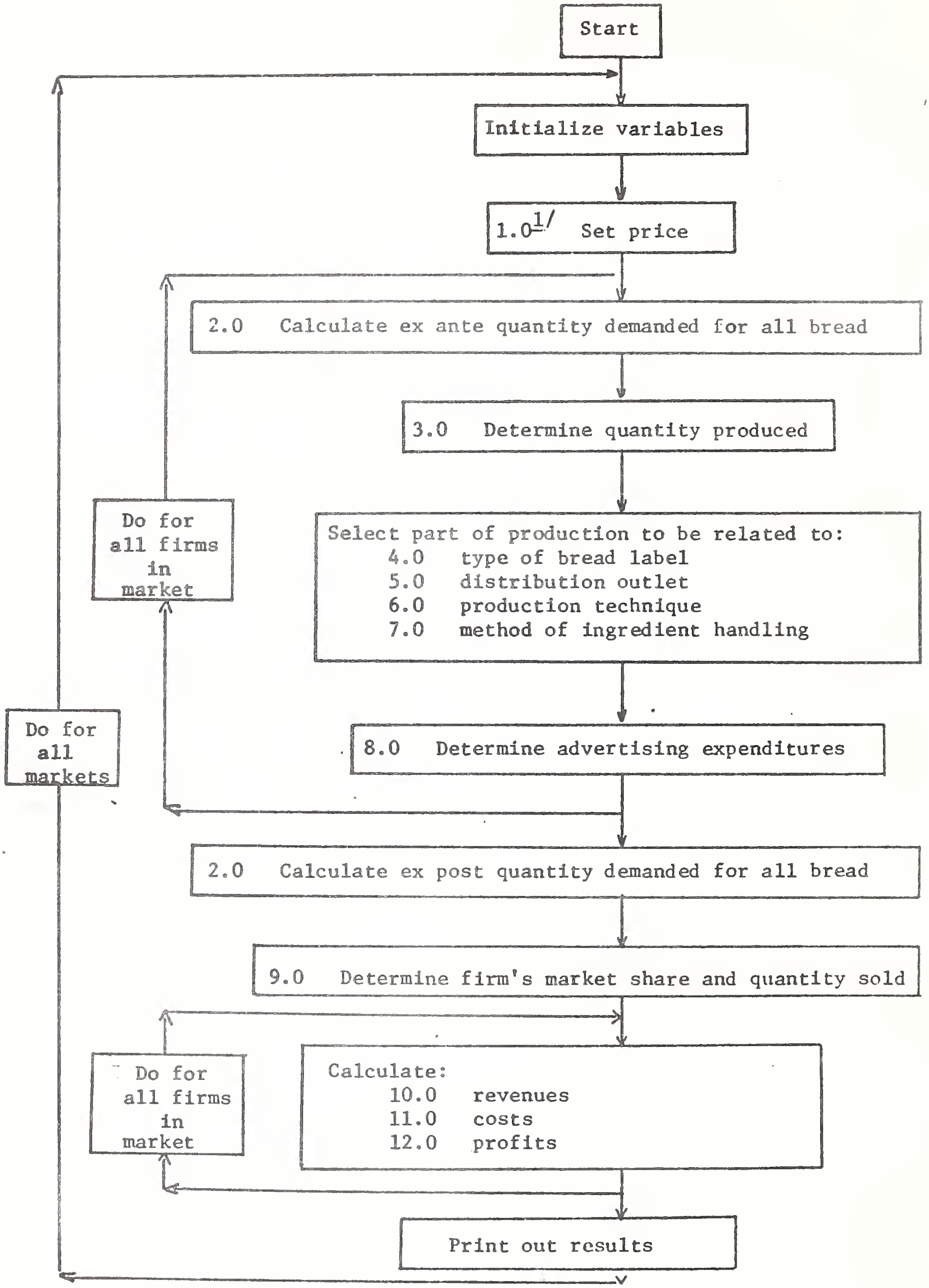
18/ Storey (42) and Walsh and Evans (55) used parameters estimated for wholesale bakers as applicable to chain store bakers when their operations coincide.



1/ The numbers denote subsystems which are defined in the text.

Figure 1--Model of bakery markets.

it is mathematical notation. The computer begins by reading-in structural variables defining the market under analysis (table 1). These include population, income, previous bread prices and consumption, and number, size, and type of firms operating in the market. Information identifying each firm is also introduced (table 2). These include their capacities, estimates of relative profits by type of distribution outlet, per unit costs and revenues, market shares, quantities sold and percent sold as rack service. The status of each firm, as identified by these variables, and the behavioral parameters associated with the size and type of firm produce individualized decisions within the model.

Prices are determined for each of the various outlets. These prices are applicable to every firm and are set in the model by a price leader firm.

Estimates of market demand are formed. Estimates are made for each firm by using the same demand function; a normally distributed error term has been included to represent differences in expectations. These expectations are carried forward to affect the firm's remaining decisions.

An estimate of a firm's probable sales is made by applying market shares to the firm's demand expectations. Production is constrained by capacity.

At this point, several decisions are made which affect a firm's revenues as well as its costs. Flour can be purchased in either bags or bulk. The baking process can be either conventional batch or continuous mix. The model has the facility to estimate these technological decisions by using a logistic adoption function or a user can prespecify the techniques. A firm can use only one type of baking process. Ingredients can be received in both bags and bulk, and permanent pneumatic handling equipment affects the percentage. The amount of flour purchased is estimated as a function of production; a normally distributed error term denotes buying fluctuations among firms. The percentage purchased in bulk depends on the acquisition of sophisticated handling equipment plus an error term. The remaining flour is in bags.

Table 1--Bread market information for market X

Item	Unit	Time period t-1 [1/]	Time period t
Bread consumption	1,000 pounds	270,820.73	NA [2/]
Bread price	¢ per pound	26.88	NA
Monthly income	$ per capita	215.80	230.00
Consumer price index	---	108.90	110.60
Population	Thousands	3,428.16	3,428.17
Baking firms [3/]	Number	NA	11
Small wholesale	Do.	NA	2
Medium wholesale	Do.	NA	3
Large wholesale	Do.	NA	4
Chain store (all sizes)	Do.	NA	2

1/ Certain decisions require information from the previous time period.

2/ NA means not available.

3/ Small wholesale firms produce less than 250,000 pounds per 80-hour week; medium firms, 250,000 to 500,000 pounds; and large firms, 500,000 pounds or more.

Table 2--Baking firm characteristics for market X

Firm class		Capacity	Continuous mix	Bulk ingredients	Quantity sold	Relative profits for-- Rack service	Home service	Drop stop	Dock pickup	Per unit revenue	Per unit cost	Quantity sold rack service	Market share
		1000 lbs. per 30 hr. wk.	yes/no	yes/no	1000 lbs. per year	Ratio to average profits				¢ per lb.	¢ per lb.	1000 lbs. per year	Percent
Wholesalers													
Small	1	242	No	No	8860.7	0.9961	0	1.0676	0.9777	26.7	26.5	8634.4	3.3
"	2	190	No	No	11355.7	1.0000	0	0.0000	1.0005	26.8	27.3	10414.9	4.2
Medium	1	436	Yes	Yes	34407.8	1.0000	0	0.0000	0.0000	27.1	27.2	34407.8	12.7
"	2	430	No	No	9033.0	1.0052	0	1.0405	0.9428	26.2	28.9	6785.9	3.3
"	3	480	No	No	14619.0	1.0000	0	0.0000	0.0000	27.1	27.9	14618.9	5.4
Large	1	595	No	Yes	29727.8	0.9907	0	1.3206	0.0000	26.3	26.0	28891.1	10.9
"	2	540	No	Yes	29472.0	0.8707	0	1.3067	0.0000	26.2	23.6	20730.2	10.9
"	3	1289	No	No	57218.2	1.0003	0	0.0000	0.9864	26.8	26.3	56183.5	21.1
"	4	714	Yes	Yes	24129.0	0.9991	0	1.1569	0.0000	26.1	24.9	23987.6	8.9
Chain store 1/	1	448	No	No	15707.6	xxx	xxx	xxx	xxx	xxx	22.7	xxx	5.8
"	2	448	No	No	15707.6	xxx	xxx	xxx	xxx	xxx	22.7	xxx	5.8

1/ Chain store input data are identical because they were synthesized for an average plant and enough plants were entered to produce a sufficient quantity to meet their market share.

The quantities of bread wrapped by type of label and distributed by type of outlet for each firm are determined as functions of production with adjustments for relative profits, risk, and random variations. The estimation of the behavioral parameters as well as the constraints in the simulation program assure consistency in the results, and all production is wrapped and distributed.

Sales promotion costs are highly related to the type of labeling and distribution outlet. Random variation is also considered part of the decision and accounts for uncertainty.

After all of these decisions have been made for each firm, the model calculates another demand estimate which is used as the resulting consumer response. This is the market's quantity sold which is shared by each firm. A firm's share is related to its size, the number and sizes of other firms, in the market, its relative sales promotion costs, and a random variable denoting "luck." If a firm's potential sales were larger than its production, then the excess is shared by the remaining firms. If sales are less than production, then overproduction is discarded. The model accounts for overproduction as it affects revenues from rack-service and home delivery.

Since production, quantity sold, and prices have been determined, the inclusion of cost parameters in the accounting functions yields profits. These calculations are made for each firm. The cost parameters vary by firm size, and the levels of the independent variables result from previous decisions.

This completes the computations for one market. The model is constructed to repeat the process for several markets or for several replications of the same market. Each market has summary statistics on the decisions and profit performance of each firm (table 3). When all markets are completed, a further summary is made for each type of firm. This information shows the means and standard deviations of the variables reported for each market.

Table 3--Management information for market X of baking industry

Firm class	Market and firm information developed by computer simulation for time period t which applies to 1/ --															
	Q	MS	OB	PL	DSWS	DSHS	DROP	DOCK	STORE	BAGS	BULK	CNTS	SP	REV	COSTS	PROFIT
	Million pounds	Percent											Cents per unit			
Wholesalers:																
Small	9.5	3.2	66.4	33.6	79.4	0.0	11.2	9.4	0	100.0	0.0	0	2.8	26.5	26.5	0.0
	12.6	4.3	81.7	183.3	84.3	0.0	14.9	0.8	0	78.1	21.9	0	6.5	27.0	26.5	0.5
Medium	34.1	11.5	99.0	1.0	85.6	0.2	1.0	13.3	0	80.6	19.4	100	3.7	26.8	26.2	0.5
	10.1	3.4	98.7	1.3	87.9	0.0	12.1	0.0	0	5.9	94.1	0	4.0	27.2	29.5	-2.0
	16.0	5.4	97.6	2.4	97.2	2.8	0.0	0.0	0	96.8	3.2	0	6.1	28.1	27.5	1.0
Large	32.9	11.1	98.2	1.8	94.6	0.0	0.0	5.4	0	39.3	60.7	0	4.7	27.5	26.3	-1.2
	32.2	10.9	100.0	0.0	98.0	2.0	0.0	0.0	0	97.3	2.7	0	8.9	28.1	29.8	-1.4
	63.7	21.5	93.6	6.4	91.5	0.2	8.3	0.0	0	75.9	24.1	0	4.5	27.5	29.3	-1.6
	27.2	9.2	95.9	4.1	84.7	7.7	7.7	0.0	0	64.7	35.3	100	4.6	28.1	25.4	2.7
Chain store	17.4	5.9	0.0	100.0	0.0	0.0	84.0	0.0	16	69.8	30.2	0	1.5	22.5	22.2	-0.3
	17.5	5.9	0.0	100.0	0.0	0.0	84.0	0.0	16	69.8	30.2	0	1.5	22.5	22.2	-0.3
Retailers	23.2	7.6														

1/ Definition of variables:

Q = quantity sold
MS = market share
OB = own brand
PL = private label
DSWS = rack service
DSHS = home service
DROP = drop stop
DOCK = bakery dock pickup

STORE = baked at the store
BAGS = bag handling of ingredients
BULK = bulk handling of ingredients
CNTS = continuous mix
SP = market maintenance and expansion expense
REV = revenues
COSTS = total costs
PROFIT = firms profits

Market information:

PRICE DSWS = 27.91 CENTS
PRICE DSHS = 36.28 CENTS
PRICE DROP = 22.33 CENTS
PRICE DOCK = 19.54 CENTS
PRICE STORE = 23.17 CENTS

MARKET DEMAND FOR BREAD = 305653.60 THOUSAND POUNDS FOR 3428. THOUSAND POPULATION
MARKET PER UNIT PROFIT = 0 CENTS

CONSTRUCTING MODEL COMPONENTS

Several empirical developments of the decision processes are discussed in detail in this section.

Pricing

The price determination process may take many forms. An in-depth study (55) of the U.S. Senate hearings (53) on administered prices in bread markets showed similarities in the price-making process among markets. This study is used as a basis to formulate the current process. Four variations in the price determination process also are presented.

Current pricing process.--The most prevalent price-making process has been for the dominant wholesale baking firm[19/] in the market to set an "umbrella price" covering average costs[20/] of all bakers in the market ". . . regardless of size or capacity utilization . . ." (55, p. 85). The incentive to behave in this manner is essentially one of avoiding cutthroat competition. Generally, other bakers found the price level "satisfactory" in terms of covering costs. They usually adhered to the umbrella price because of an "identity of interest" in maintaining returns on investment rather than because of joint profit maximization (55, p. 83). The price determination process of the chain store bakers tends ". . . to conform with the price policies of the wholesale bakery oligopoly core . . ." (55, p. 102).

19/ In some cases, a multistate corporation baker who had a relatively low profit rate would emerge as the price leader, even though he was not the dominant firm in the market (55, p. 86).

20/ Costs are generally known in the industry through trade reports that publish various informational and advisory materials.

Generally, bakers change their prices quickly in response to a leader. Of the 80 price changes in 24 cities from 1952 to 1958 that were investigated by the U.S. Senate (54, pp. 146-147), most bakers adjusted their prices to the same level within 4 days of the increase by the price leader. This almost instantaneous information feedback resulted from chain grocers requiring prenotification of price changes and passing the information to other driver-salespersons servicing the store (55, p. 86).

There are several prices for bread, each associated with a different type of distribution outlet. The NCFM (27) surveyed wholesale bakers' net sales for 14 different categories of outlets. For simplicity, this study groups all of these outlets into four types of outlets: (1) driver-salesperson wholesale in which the driver-salesperson delivered bread to grocers' shelves; (2) driver-salesperson home service in which the driver-salesperson delivered bread to consumer homes; (3) drop stop in which bakers' delivery persons transported bread to grocers' docks; and (4) dock pickup in which grocers picked up bread at bakers' docks. Distribution points may be at bakery plants or depots many miles from those plants.

Interplant sales involve double accounting, that is, sales of the producing firm and resales for the purchasing firm. Hence they were subtracted from total sales. Warehouse delivery, owned and retail stores, and all other sales were grouped with the drop-stop outlet. Since sales at thrift stores are usually returns associated with driver-salesperson wholesale and home service, they were divided proportionately among these outlets.

In the following model the pricing policy just outlined is followed, that is, price is an umbrella level and is set by a price leader.[21/] All other bakeries

21/ The dominant firm in the market is probably the price leader; but it is not specified, since who sets price is not important in the model.

are assumed to follow the price leader instantaneously. The leader sets the price of the driver-salesperson wholesale outlet (P_{dsws}) so that it is equal to the average cost (AC_i) of the highest cost producer who has distributed at least k percent of his production via driver-salesperson wholesale ($PCTQ_{i,dsws}$). This information is part of the model's data input for each firm. Discussions with baking industry personnel indicated that prices of all other distribution outlets (P_{dshs}, P_{drop}, and P_{dock}) are determined proportionately to P_{dsws}. Chain store bread is assumed to be priced (P_{stor}) likewise. Therefore, the price leader effectively sets a vector of bread prices for all bakers. The current price determination process is formulated as:22/

Subsystem 1.0

(1.1) $P_{dsws} = \max [AC_i]$ for $i = 1, 2, \ldots, n$; and subject to

$PCTQ_{i,dsws} > k$; for $0 < k < 1.0$;

(1.2) $P_{dshs} = \alpha_1 P_{dsws}$;

(1.3) $P_{drop} = \alpha_2 P_{dsws}$;

(1.4) $P_{dock} = \alpha_3 P_{dsws}$; and

(1.5) $P_{stor} = \alpha_4 P_{dsws}$.

Since wholesale bakers generally distribute a large percentage of their production through wholesale driver-salespersons, k was set at 0.75.23/

22/ A summary of the mathematical systems model is reported in Appendix table 1. Appendix table 2 gives a definition of the variables.

23/ In 1964, small, medium, and large wholesale bakers distributed 81.5, 80.1, and 74.3 percent of their production via driver-salesperson wholesale, respectively (27, p. 82). The 0.75 figure was applied here since it is doubtful that price leading firms would ignore the relevance of the large wholesale bakers in establishing price. It is also likely that in many markets the price leader is a large firm.

Other values could also be used to determine how sensitive the model is to this parameter estimate.

The relative proportions in prices between the various types of outlets for wholesale bakers were supplied by William Botty, Director of Merchandising, Quality Bakers of America. The relative proportion of P_{dsws} to P_{stor} was obtained (55, p. 103). Thus, the parameters are:

$k = 0.75$

$\alpha_1 = 1.30$

$\alpha_2 = 0.80$

$\alpha_3 = 0.70$

$\alpha_4 = 0.83.$

Alternative price process.--A variation of the proportionate price determination process considered by the wholesale baking industry (4, p. 7), is to base prices on the exact differences of costs of services among various types of outlets. This first alternative price determination process may be represented as:

Subsystem 1.0'

(1.1') $P_{dsws} = \max\ [AC_i]$ for $i = 1, 2, \ldots, n$; and subject to $PCTQ_{i,dsws} > 0.75$;

(1.2') $P_{dshs} = P_{dsws} + \delta_1$;

(1.3') $P_{drop} = P_{dsws} + \delta_2$;

(1.4') $P_{dock} = P_{dsws} + \delta_3$; and

(1.5') $P_{stor} = P_{dsws} + \delta_4$.

Although exact cost differences for wholesale bakery outlets were estimated in an economic engineering study as part of the Computer Optimization and Simulation Modeling for Operating Supermarkets (COSMOS), they were not available at the time of this study. Thus, three sets of estimates were generated: (1) those which would develop prices equivalent to the relative proportions of the

current pricing decision process, where P_{dsws} = 19.2 cents per pound, that is, the mean white pan bread price during January 1954 to October 1969 in 1958 prices (50); (2) those representing the mean differences in costs of distribution and promotion for each outlet from that of dsws (developed from table 9); and (3) those representing the mean differences in costs of distribution, promotion, and labeling for each outlet from that of dsws (developed from table 9 on the assumption that dsws and dshs use ob and that drop and dock use pl). The chain store price difference is from historical data (55, p. 103). The estimated parameters for the alternative price determination policy are:

Cost differences	Estimates of δ_i based on (1)	(2)	(3)
	Cents per pound		
δ_1	5.82	4.32	4.32
δ_2	-3.88	- .94	- .97
δ_3	-5.82	- .81	- .84
δ_4	-3.30	-3.30	-3.30

Admittedly these are rough estimates which indicate that wholesale bakers charge a premium of 5.8 cents per pound to deliver bread to the home. But their cost figures show that they could do it for 4.3 cents. Second, they provide discounts for drop-stop and dock-pickup outlets which are greater than their actual cost savings. Thus, in a minimum cost sense, wholesale bakers may be misallocating quantities of bread by types of outlets.

Output

In contrast to determining quantity manufactured within the firm by setting marginal revenue equal to marginal cost (55, p. 83), wholesale bakers wish to maintain their respective market shares over the previous J periods. This can

be shown as--$MS = \left[\sum_{j=1}^{J} QS_{i,t-j} \bigg/ \sum_{j=1}^{J} CD_{t-j} \right]$.

Although some bakers might improve their profit performance by increasing their market share, there is some reluctance to do so. Apparently, the "identity of interest" which causes bakers to use umbrella pricing also causes them to restrain production in order to avoid cutthroat competition. When the firm's market share is multiplied by its estimate of the market demand for bread (CD_t) production (QP_i^*), it is subject to the restriction that the actual production (QP_i) cannot exceed capacity (QC_i).[24/]

Since CD_t is not known with certainty, there is the possibility that bakers in the model will, in aggregate, overproduce or underproduce. If bakers overproduce, they are confronted with unsalable stale bread.[25/] If they underproduce, the market is not satiated. But contrary to excess demand for some consumer items, this excess demand vanishes and does not carry forward as a pent-up demand.[26/]

Determining quantity produced requires the specification of the unit of times to be simulated and one parameter--J--which is the number of periods to maintain market shares. The unit of time to be simulated was chosen as a year

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24/ Exceeding capacity is not likely since the industry usually operates with considerable excess (55, pp. 58-67; 27, p. 55).

25/ Salable stales are accounted for in the model by including them as production sold in the other types of outlets. The effect of stales is a cost of selling and distribution for those outlets.

26/ This seems to be a reasonable simplification since bread is produced regularly. Thus for example, just because a consumer did not obtain six slices of bread today does not mean that he will demand an additional six slices tomorrow.

because of the time period represented in the data (27). The parameter estimate of J establishes the number of years over which firms try to maintain their market share. This value was chosen arbitrarily as 1.0, because the data did not contain time series (27). Since market shares in the baking industry are probably relatively constant over time, the following was used to estimate the production decision process:[27/]

Subsystem 3.0

$$(3.1) \qquad QP^* = (QS_{t-1} \big/ CD_{t-1}) * E(CD_t); \text{ and}$$

$$(3.2)^{28/} \qquad Q_{manu} = \begin{cases} QP^*, \text{ if } QP^* \leq 1.5*QC; \\ 1.5*QC \text{ otherwise.} \end{cases}$$

Labeling

This study considers two categories for labeling own brand and private label. Wholesale bakers often produce an advertised brand and one or more private labels for other distributors. Although chain stores may produce many different brands of bread, they are all categorized as private label. Thus in this study, chain stores are shown to produce only a single type of label.

Formulation of decision framework.--This decision process determines the quantity of bread wrapped under different types of labels by wholesale bakers--own brand (Q_{ob}) and private (Q_{pl}). They must equal the total quantity manufactured (Q_{manu}).

27/ Although this decision process has been formulated for wholesale bakers, it is assumed that chain store bakers behave in the same way.

28/ Since QC represents a normal working situation with two 8-hour shifts, physical capacity was increased by 50 percent to allow for the possibility of three 8-hour shifts.

The ability of a baker to shift dramatically from one type of label to another has been limited. Labeling practices are highly associated with types of outlets, for example, private label would not be sold as home delivery. A drastic change in labeling would also mean a significant shift in distribution practices. Such changes have not occurred easily because of labor contracts with salespersons, inability to effectively change shelf space allocation within supermarkets, and bakers' resistance to the private label movement. Rather than considering this decision process as a mathematical programming problem of optimizing a firm's profit, subject to resource, institutional, and management flexibility restraints, it was decided to develop it in a behavioral setting which would describe how bakers respond to economic stimuli. Certainly profit plays a role in the decision process, but the role has some constraints.

Major changes in labeling and distribution can be seen as longrun decisions. But this model has more of a shortrun duration. As management's perception of demand and profit conditions alters over time, it is expected that these decision equations would also be altered.

Economics of firm behavior suggests that profit and risk influence the decision regarding the quantities of bread distributed by types of labels. The profit variable for each label was formulated as the ratio of the profit from a given label--if profit measures the difference between price and costs per unit of wrapping and advertising--to the weighted profit from all labels. For example, $\frac{\pi_{ob}}{\pi_{all}}$ denotes the wholesale baker's own brand relative profits.

A risk variable was formulated for each type of distribution outlet. A single risk variable was used as a surrogate for the others, since the price-making process implies a near perfect correlation in the variables for risk among labels. It was measured as the squared difference between the weighted market price and the price received by the firm. One could expect that as this

variable increased the firm would channel less of its product through its brand and more through private label.

The NCFM data (27) provides detailed revenue and cost breakdowns by type of distribution outlet but only detailed revenue information by type of label. Thus, relative profits by type of label could not be generated. Since there was high correlation between quantities labeled as own brand and quantities distributed by driver-salespersons for wholesale (r=0.91), profits by types of outlets, for example, $\frac{\pi_{dsws}}{\pi_{all}}$, $\frac{\pi_{dshs}}{\pi_{all}}$, $\frac{\pi_{drop}}{\pi_{all}}$, $\frac{\pi_{dock}}{\pi_{all}}$, were used as proxies for profits by types of labeling.

Preliminary analyses showed that several other possible factors, which at first might be expected to influence the decision process, were not statistically significant. For instance, the nature of the other firms' allocation of types of labels did not affect a given firm's allocation of quantity manufactured to its particular type of label. Similarly, the profits from baking relative to those from all other types of manufacturing (representing alternative uses of funds) did little to change the decision process. The subsystem was formulated as:

Subsystem 4.0

(4.1) $Q_{ob} = X_1\beta + U_1$;

(4.2) $Q_{pl} = X_2 b$;

where $X_1 = \left[Q_{manu}, \frac{\pi_{dsws}}{\pi_{all}}, \frac{\pi_{dshs}}{\pi_{all}}, \frac{\pi_{drop}}{\pi_{all}}, \frac{\pi_{dock}}{\pi_{all}}, \sigma^2 \right]$;

β denotes the column vector of parameters associated with X_1;

$b = \left[(1.0 - \beta_1), (-\beta_2), (-\beta_3), (-\beta_4), (-\beta_5), (-\beta_6) \right]$, and $U_1 \sim N(0,s^2)$.

Statistically estimating behavioral parameters of labeling.--Two approaches can be used to estimate this decision framework. One approach involves estimating the equations separately by least squares and satisfying the restriction

that the predicted values of Q_{ob} and Q_{pl} sum exactly to Q_{manu} with a normalizing procedure.

The other approach, applied here, considers this summation in the estimating process and is called "estimation of seemingly unrelated regressions" (59, 33). Powell proved mathematically that if a predetermined aggregate is being allocated (in this case, Q_{manu}), the sum of its coefficients across allocating equations must equal one. For example, all Q_{manu} is allocated to Q_{ob} and Q_{pl} for wholesale firms, and all Q_{manu} is allocated to Q_{pl} for chain store bakers. The coefficients of other variables which are common to each equation must sum to zero for each variable across equations. For example, the sum of the coefficients of $\frac{\pi_{dsws}}{\pi_{all}}$ across the wholesalers' two equations must equal zero. Moreover, any variables, whose parameters are identical from equation to equation, must be defined so that their observations sum to zero across equations. Thus, except for the predetermined aggregate, either the parameter values or the values of the variables themselves must sum to zero across equations.29/

In this approach, the parameters associated with each outlet can be estimated separately by least squares (59, 33), a procedure which provides best linear unbiased estimates of the coefficients. Also, only the parameters associated with one of the labels need be estimated by regression, because the parameters of the other label can be obtained by using restrictions on the model.

To represent behavior differing by type of firm, subsystem 4.0 was estimated separately for small, medium, and large firms. These firms have 0-250,000, 250,000-500,000, and more than 500,000 pounds baking capacity per 80-hour week,

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29/ Intuitively, these zero restrictions are sound. Any adjustment in Q_{ob} because of a change in the value of one of these variables must have an equally offsetting adjustment on Q_{pl} so that their sum remains equal to Q_{manu}.

respectively. Appendix B explains why this structural classification was chosen. Parameter estimates and other statistical information are shown in table 4.

For each size of firm, the R^2 is high for the own brand label but low for the private label brand. Total error among brands is identical, because predictive error in own brand label is exactly offset by predictive error in private label ($S_{\hat{y}}$ in table 4). Moreover, own brand represents a high proportion of a total quantity manufactured, but private label is more of a residual.

The quantity to be allocated (in this subsystem, Q_{manu}) is the most important variable. All the signs on the coefficients of Q_{manu} are positive; and all but one--the coefficient of Q_{manu} in the private label equation for small wholesalers--are significantly different from zero. Other things equal, small and large firms would allocate about 97 percent of an increase in Q_{manu} to be wrapped under their own labels, but medium firms would allocate about 90 percent.

The coefficients on profits generally show the expected signs. Wholesalers ordinarily distribute their own brand through driver-salespersons for wholesale and home service outlets and private label through drop-stop or dock-pickup outlets. Thus, it is expected that the own brand label is positively related to driver-salesperson delivery and negatively related to the other outlets. Also it is expected that the private label relationships are reversed. Although medium and large firms bear this out empirically, medium firms are the only wholesalers that have coefficients significantly different from zero.

None of the firms show much risk aversion. The estimated parameter values are insignificantly different from zero. However, this variable was kept in the subsystem so that the decision process conforms to the distribution decisions process.

Chain store bakers were restricted to a single type of bread--private label. Consequently, the coefficient on Q_{manu} is 1.0.

Table 4--Bread label types: behavioral parameters of baking firms related to selection and extent of use

Type of bread label by kind of firm, Q_i	Coefficients for[1/] --						R^2	$\hat{S}_y$	$\bar{Q}_i$ [2/]
	Q_{manu}	$\frac{\pi_{dsws}}{\pi_{all}}$	$\frac{\pi_{dshs}}{\pi_{all}}$	$\frac{\pi_{drop}}{\pi_{all}}$	$\frac{\pi_{dock}}{\pi_{all}}$	σ^2			
Small wholesale: (N=113)									
Own brand	0.976*	-0.15	-0.05	-0.15	-0.23	-0.0056	0.959	1.13	7.87
	(0.019)	(0.21)	(0.42)	(0.21)	(0.22)	(0.0084)			(5.46)
Private label	0.024	0.15	0.05	0.15	0.23	0.0056	0.048	1.13	0.51
	(0.019)	(0.21)	(0.42)	(0.21)	(0.22)	(0.0084)			(1.13)
Medium wholesale: (N=245)									
Own brand	0.892*	1.21*	0.34	-0.98*	-0.20	-0.0028	0.891	2.20	15.19
	(0.018)	(0.34)	(0.62)	(0.26)	(0.28)	(0.0095)			(6.59)
Private label	0.107*	-1.21*	-0.34	0.98*	0.20	0.0028	0.178	2.20	1.09
	(0.018)	(0.34)	(0.62)	(0.26)	(0.28)	(0.0095)			(2.40)
Large wholesale: (N=102)									
Own brand	0.967*	0.59	0.17	-0.35	-0.67	-0.0100	0.987	2.51	31.78
	(0.015)	(0.77)	(1.06)	(0.49)	(0.55)	(0.0300)			(16.42)
Private label	0.033*	-0.59	-0.17	0.35	0.67	0.0100	0.046	2.51	1.11
	(0.015)	(0.77)	(1.06)	(0.49)	(0.55)	(0.0330)			(2.51)
Chain store:[3/]									
Own brand	0.0								0.0
Private label	1.0								16.28

1/ Coefficients significantly different from zero at the 5 percent level are denoted by *. Standard errors of the parameter estimates are in parentheses.

2/ Mean values of the dependent variables are in million pounds per year. Standard errors are in parentheses.

3/ These estimates recognize that all chain store bread is under private label and assume that the size of chain store baker is same as that of the mean medium wholesale baker.

Distribution

The four basic types of outlets--driver-salesperson wholesale, driver-salesperson home service, drop stop, and dock pickup--not only have different price levels, but they also have different cost levels. Thus, a firm may improve its profit picture if it can select those outlets which most improve net revenues.

As was discussed in the labeling decision process, major shifts in quantities distributed by type of outlet have not been significant. A major shift entails a change in labeling, sales promotion, sales staff, and management philosophy, all of which affect a firm's response to economic stimuli. The formulation for distribution is similar to that for labeling.

Formulation of decision framework.--The distribution decision center determines the quantities a firm is going to distribute by type of outlet. These quantities are defined as quantity driver-salesperson wholesale (Q_{dsws}), quantity driver-salesperson home service (Q_{dshs}), quantity drop stop (Q_{drop}), and quantity dock pickup (Q_{dock}). They must sum to the total quantity available for sale (Q''). As in the labeling decision process, these allocations were affected by the relative profits of the distribution outlets and risk.

Analysis of bakery operations indicates that quantities wrapped by type of label may affect the distribution decision. Private label bread is not distributed either through driver-salespersons for wholesale outlets or for home service outlets. Thus, quantities distributed through these outlets may decrease as the quantity wrapped as private label (Q_{pl}) increases.

Chain store bakers' choice of distribution outlets for their production is much more restricted. They produce bread either at the grocery store or at a central plant and deliver it to stores' docks. Because of a lack of data on chain store operations, it is postulated that their quantities delivered to grocery stores (Q_{drop}) and their quantities baked at the store (Q_{stor}) are

affected only by Q". The subsystem of equations describing the distribution decision process is represented as follows:

Subsystem (5.0)

(5.1) $Q_{dsws} = X_1\beta_1 + U_1;$

(5.2) $Q_{dshs} = X_2\beta_2 + U_2;$

(5.3) $Q_{drop} = X_3\beta_3 + U_3;$

(5.4) $Q_{dock} = X_4 b_4$

(5.5) $Q_{stor} = Q''\gamma$

where $X_i = \left[Q'', Q_{pl}, \frac{\pi_{dsws}}{\pi_{all}}, \frac{\pi_{dshs}}{\pi_{all}}, \frac{\pi_{drop}}{\pi_{all}}, \frac{\pi_{dock}}{\pi_{all}}, \sigma^2 \right]$; β_i denotes the column vector of parameters associated with X_i; $b_4 = \left[\left(1.0 - \sum_{i=1}^{3} \hat{\beta}_{i1} \right), \left(- \sum_{i=1}^{3} \hat{\beta}_{ij} \right), j = 2, 3, \ldots, 7 \right]$; and $U_i \sim N(0,\sigma_i^2)$.

Statistically estimating behavioral parameters.--Only three of the four equations in subsystem 5.0 were estimated by separate regressions because of the restrictions outlined in the labeling section.30/ But the final equation was also regressed to obtain information concerning the significance of the parameters. Parameter estimates and other statistical information are shown in table 5.

Explanation of total variance (R^2) varies widely among equations. The R^2 values for the Q_{dsws} outlet are high for all sizes of firms. They are generally quite low for other types of distribution outlets. This results for several reasons. Driver-salesperson wholesale distribution is the major outlet, as indicated by its mean quantity which is more than 10 times the mean quantity distributed through any other type of outlet. The subsystem must always be in

30/ If the formulation had required estimation of a parameter that was identical for all equations, the subsystem would need to be estimated simultaneously.

Table 5--Types of distribution outlets: behavioral parameters of baking firms related to selection and extent of use

Type of distribution outlet by kind of firm	Q_i [2/]	Q''	Q_{pl}	$\frac{\pi_{dsws}}{\pi_{all}}$	$\frac{\pi_{dshs}}{\pi_{all}}$	$\frac{\pi_{drop}}{\pi_{all}}$	$\frac{\pi_{dock}}{\pi_{all}}$	σ^2	R^2	$\hat{S}_y$
		Coefficients for [1/] --								
Small wholesale: (N=113)										
Driver-salesperson wholesale	8.05 (6.22)	0.915* (0.025)	-0.038 (0.136)	0.96* (0.29)	-1.39* (0.59)	-0.31 (0.30)	-2.00* (0.31)	-0.0057 (0.0118)	0.939	1.58
Driver-salesperson home service	0.10 (0.59)	0.007 (0.007)	-0.062 (0.039)	-0.06 (0.08)	1.42* (0.17)	0.21* (0.09)	-0.10 (0.09)	0.0007 (0.0034)	0.434	0.46
Drop stop	0.26 (0.65)	0.008 (0.008)	0.144* (0.047)	-0.09 (0.10)	0.10 (0.20)	0.62* (0.10)	-0.05 (0.11)	-0.0027 (0.0040)	0.337	0.54
Dock pickup	0.58 (1.75)	0.070* (0.022)	-0.044 (0.122)	-0.81* (0.26)	-0.13 (0.53)	-0.52** (0.27)	2.15* (0.28)	0.0077 (0.0105)	0.380	1.42
Medium wholesale: (N=245)										
Driver-salesperson wholesale	15.08 (7.86)	0.878* (0.020)	-0.312* (0.074)	2.98* (0.37)	-3.60* (0.71)	-0.87* (0.31)	-2.73* (0.32)	-0.0539* (0.0109)	0.900	2.51
Driver-salesperson home service	0.15 (0.83)	-0.004 (0.003)	0.001 (0.011)	0.04 (0.06)	3.21* (0.11)	-0.01 (0.05)	0.08 (0.05)	0.0007 (0.0016)	0.801	0.37
Drop stop	0.66 (1.63)	0.009 (0.010)	0.324* (0.036)	-0.29 (0.18)	0.93* (0.34)	0.97* (0.15)	-0.07 (0.16)	-0.0042 (0.0053)	0.458	1.22
Dock pickup	0.89 (3.09)	0.117* (0.019)	-0.013 (0.068)	-2.73* (0.34)	-0.54 (0.65)	-0.09 (0.28)	2.72* (0.30)	0.0574* (0.0099)	0.452	2.31
Large wholesale: (N=102)										
Driver salesperson wholesale	30.82 (17.55)	0.814* (0.040)	-0.179 (0.287)	10.07* (2.07)	-16.20* (2.94)	-3.19* (1.37)	-3.59* (1.52)	-0.4462* (0.0921)	0.853	6.93
Driver-salesperson home service	1.17 (4.97)	0.005 (0.009)	0.027 (0.063)	-0.15 (0.46)	19.17* (0.65)	-0.02 (0.30)	0.03 (0.34)	-0.0164 (0.0203)	0.911	1.53
Drop stop	1.50 (3.76)	0.046* (0.017)	0.554* (0.124)	-3.12* (0.90)	-2.92* (1.27)	3.54* (0.59)	-0.73 (0.66)	0.0206 (0.0399)	0.402	3.00
Dock pickup	1.53 (8.16)	0.135* (0.037)	-0.402 (0.264)	-6.80* (1.91)	-0.05 (2.71)	-0.33 (1.26)	4.29* (1.40)	0.4420* (0.0849)	0.424	6.39
Chain store: [3/]										
Drop stop	14.09	0.840								
Baked at store	2.68	0.160								

1/ Coefficients significantly different from zero at the 5 percent level are denoted by * and at the 10 percent level by **. Standard errors of the parameter estimates are in parentheses.

2/ Mean values of the dependent variables are reported in million pounds per year. Standard errors are in parentheses.

3/ These estimates are derived from annual surveys (3) and assume that size of the chain store baker is the same as that of the mean medium wholesale baker.

balance, for example, an increase in Q_{dsws} causes an offsetting decrease in at least one of the other outlets. Thus, coefficients of variation associated with a minor outlet must be high and lead to its poorer prediction. Nevertheless, if Q_{dsws} can be predicted well, the entire subsystem is doing a "good job" of prediction, precisely because Q_{dsws} represents a high percentage of Q''.

In general, the estimated relationships reflect intuitive expectations. Q'' is the most important variable in the subsystem, in the sense that its value is allocated to types of distribution outlets. Since driver-salesperson wholesale outlet is the largest single outlet, its coefficients on Q'' proved to be the largest. In this study, these coefficients are greater than 0.8 for all sizes of firms. Furthermore, these parameter estimates decrease as size of firm increases, a factor which may show that small firms are more committed to driver-salesperson wholesale outlets than are larger firms. This tendency is expected, because other outlets may lend themselves to large-scale operations since they are usually served on a contractual basis. Also, bakers often do not desire a single contract to represent a large proportion of their total production.

For the other types of distribution outlets, the coefficients of Q'' generally do not differ significantly from zero but are kept in the decision framework in order to conform to the constraints. All signs, however, on these coefficients are positive, except for driver-salesperson home service outlets of medium-size firms. Since driver-salesperson home service outlets are a costly distribution system, it is not surprising that firms commit such a small percentage (less than one percent) of their production to these outlets.

The drop-stop delivery and dock-pickup outlets increase with respect to Q'' coefficients as the size of firm increases. Furthermore, the dock-pickup coefficients for the medium and large firms are statistically significant as is the drop-stop coefficient on Q'' for the large firms. This is as expected.

Medium and large firms may be more responsive to other types of outlets than are small firms, for reasons as discussed above.

Coefficients of Q_{pl} for drop-stop delivery are significantly different from zero for all types of firms. They are generally not significant for other types of distribution outlets. An increase in Q_{pl} is associated with a decrease in Q_{dsws} for all types of firms as would be expected; but the parameter estimates are statistically significant only for medium firms. A decrease in Q_{dsws} associated with an increase in Q_{pl} is offset by an increase in Q_{drop}. Thus, the analysis supports the observation that drop stop is the usual form of delivery for the private label bread.

Each outlet's own profit variable has the expected positive relationship, that is, its quantity increases as its profit increases. The own-profit variables are significant for all types of firms and are shown on the diagonal for those variables in table 5. For the major outlet, driver-salesperson wholesale, the coefficients show that as size of firm increases, firms allocate greater percentages to rack service as that outlet's profit rises. In fact, it shows that medium firms are about three times more responsive to $\frac{\pi_{dsws}}{\pi_{all}}$ than small firms (2.98 versus 0.96). Large firms are about three times more responsive to such changes than medium firms (10.07 versus 2.98). Although profits off the diagonal do not generally differ significantly from zero, they have the expected signs in all but six cases and must be kept in the subsystem to maintain consistency.

Risk aversion increases as size of firm increases. Coefficients on σ^2 for the driver-salesperson wholesale outlet are about 10 times as great for medium firms as for small firms. Similarly, coefficients for large firms are about 10 times the level for medium firms. Medium and large firms transfer most of the change in Q_{dsws} resulting from a change in σ^2 to Q_{dock}. Only these two sizes

of firms and these two types of distribution outlets have significant coefficients on σ^2.

These estimates may result because dock pickup is often on a contractual basis, but rack service is consigned. This often leads to returned bread and increased risk. Small bakeries may not have so much accessibility to the contract market as large bakeries, thereby restricting their effective response to increasing risk.

Chain store bakers' choice of distribution outlets was restricted to two types--drop-stop delivery or baked at the store. Analysis of annual surveys of the baking industry (3) showed that chain stores produced about 84 percent of their output at bakery plants and 16 percent at the store. All bread produced at bakery plants was assumed to be drop-stop delivered, and all bread produced at the store was assumed to be sold at the store. In addition, the chain store baker was assumed to be the same size as the mean medium wholesale baker, thus accounting for the reported mean values of quantities by type of outlet.

Production and Ingredients

These subsystems pertain to the technological processes adopted by the firm as well as the procurement of basic ingredients for production. Bakers use a production process of either conventional batch dough mixing or continuous dough mixing (subsystem 6.0). Somewhat interrelated to the mixing technology is the method of ingredient handling--bulk containers or bags (subsystem 7.0).

Continuous mix is the more recent production technique, and it results in lower costs than conventional batch mix for all sizes of firms. Bulk handling tends to be associated with the continuous mix operation, although it is not essential. For static, comparative analyses of existing bread markets, the technological processes of mixing and ingredient handling are specified for

particular firms. In other words, these two subsystems are given rather than determined within the model. However, for analyses of future market situations, the adoption of new technologies can be forecast (in a stochastic sense) through various types of functions. Technology adoption can be incorporated into the model through the use of logistic functions which were estimated (26) and reflect the rate at which continuous mix and bulk handling techniques were initiated by bakery firms. Since this study is concerned with static comparative situations, these parameters are taken as given.

The second part of the ingredient handling subsystem, however, allocates the quantity of flour purchased to bags and bulk. This does not follow entirely from the nature of ingredient handling equipment.

In deciding the percentages of flour to be purchased in bags and in bulk, the total quantity of flour required is first determined, and then it is allocated according to the two forms of supply.31/ Total quantity of flour (Q_{flour}) is a function of Q_{manu}.32/ The allocation process is affected by whether a firm has bulk equipment. The relationships may be represented as:

Subsystem 7.0

$$(7.5) \quad Q_{flour} = \alpha Q_{manu} + U_1;$$

$$(7.6) \quad \frac{Q_{bulk}}{Q_{flour}} = \beta_1 + \beta_2 BULK + U_2;$$

31/ Even though bakers do not have permanent bulk handling equipment, they may purchase bulk flour in portable bins. Bakers may also purchase flour in bags even though they have permanent bulk equipment, in order to extend their capacity or if bulk flour is not available.

32/ The NCFM (27, p. 140) found that wholesale bakers would obtain 158.4 pounds of this bread from 100 pounds of flour for their volume selling loaf of white pan bread. This mean yield had a relatively small standard error of 7.82.

$$(7.7)\quad \frac{Q_{bags}}{Q_{flour}} = b_1 + b_2 BULK;$$

where $b_1 = \left[1.0 - \hat{\beta}_1 \right]$; $b_2 = \left[-\hat{\beta}_2 \right]$; and $U_i \sim N(0,\sigma_i^2)$.

The latter part of subsystem 7.0 (7.3, 7.4, and 7.5) was estimated by two techniques. Simple linear regression was applied to the physical relationship exemplified by the Q_{flour} equation. Seemingly unrelated regression was applied to the latter equations because of their interdependencies. The parameter estimates and other statistical information are reported in table 6.

Explanation of total variance is very high for the Q_{flour} regressions and much lower for the other regressions.[33/] Better explanation in the former may result because bakers use similar bread formulas.[34/] Since the percentages in bulk and bag can be used to obtain Q_{bulk} and Q_{bags}, the R^2 was re-estimated to indicate the explanation of total variance for the quantities. As shown in table 6, the reformulated R^2 values are considerably higher, at least for bulk handling, than those developed from the original least squares regressions.

33/ The standard errors of the latter dependent variables are identical, because these variables sum to one for each observation. Thus, a change in one of the dependent variables is associated with an equal but opposite change in the other dependent variable. Since the same set of independent variables are used in both equations, the $S_{\hat{y}}$ and R^2 values are identical.

34/ The coefficient on Q_{manu} is the amount of flour needed to produce a pound of bread. USDA (44, p. 8) used 0.641 pound of flour to produce one pound of white pan bread before 1963 and 0.6329 thereafter.

Table 6--Ingredient handling methods: flour requirement parameters and behavioral parameters related to extent of use

Flour and type of handling by kind of firm	Q_i 2/	Coefficients for 1/-- Constant	Q_{manu}	BULK	R^2	$S_{\hat{y}}$	Reformulated R^2 3/
Small wholesale: (N=106)							
Q_{flour}	5.344 (3.191)		0.599* (0.006)		0.956	0.673	
Q_{bulk}/Q_{flour}	0.393 (0.480)	0.131		0.840* (0.059)	0.664	0.280	0.813
Q_{bags}/Q_{flour}	0.607 (0.480)	0.869		-0.840* (0.059)	0.664	0.280	0.710
Medium wholesale: (N=281)							
Q_{flour}	9.869 (4.907)		0.631* (0.006)		0.886	1.660	
Q_{bulk}/Q_{flour}	0.728 (0.430)	0.302		0.623* (0.041)	0.456	0.318	0.784
Q_{bags}/Q_{flour}	0.272 (0.430)	0.698		-0.623* (0.041)	0.456	0.318	0.418
Large wholesale: (N=107)							
Q_{flour}	19.167 (9.192)		0.582* (0.008)		0.901	2.897	
Q_{bulk}/Q_{flour}	0.785 (0.383)	0.500		0.430* (0.067)	0.283	0.326	0.617
Q_{bags}/Q_{flour}	0.215 (0.383)	0.500		-0.430* (0.067)	0.283	0.326	0.171
Chain store: 4/							
Q_{flour}	9.869		0.631				
Q_{bulk}/Q_{flour}	0.728	0.302		0.623			
Q_{bags}/Q_{flour}	0.272	0.698		-0.623			

1/ Coefficients significantly from zero at the 5 percent level are denoted by *. Standard errors of the parameter estimates are in parentheses.

2/ Mean values of Q_{flour} are reported in million pounds per year. Mean values of remaining dependent variables are reported as proportions. Standard errors are in parentheses.

3/ R^2 was reformulated to indicate the explanation of total variance for Q_{bulk} or Q_{bags}.

4/ Estimates are based on the assumption that the chain store baker is the same size and has behavior similar to that of the medium wholesalers.

Possession of bulk equipment significantly affects the proportion of flour purchased in bulk for all sizes of firms.[35/] If they install airslide or bulk bin equipment, small firms will shift from 13 to 97 percent bulk flour, medium firms will shift from 30 to 92 percent bulk flour, and large firms will shift from 50 to 93 percent bulk flour. So regardless of size of firm, they will purchase more than 90 percent of the flour as bulk if major bulk handling equipment is installed.

Sales Promotion

Advertising and sales promotion are used to increase sales for both a firm and the industry. A firm may attempt to make its demand function inelastic so that by raising price it can increase total revenue. Similarly by shifting its demand curve to the right, the firm may increase its share of the market. Many industries use sales promotion as a tool of market expansion and know that it benefits all firms.

Traditional economic theory provides a firm with little information for allocating funds to sales promotion. It simply states that a firm will choose a promotion budget and product price so that the marginal cost is equal to marginal return. This equilibrium position is unquestionable. But it is not possible to state categorically whether output will be larger or smaller if these costs are increased (36, pp. 41-42). Nor is it possible to unambiguously point out the effect on price.

Analysis of sales promotion over time in a hypothetical situation showed that promotion can eventually weaken the market position of a product whose success it was intended to promote (13). For example, if demand is uniformly distributed over time, improperly executed funds can produce peaks and valleys in the sales

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35/ BULK is a qualitative variable. It equals one if a firm had permanent bulk equipment, and it equals zero if the firm did not.

pattern. This increases production and distribution costs. Several methods actually used by firms were studied (10).[36/] They are (1) percentage of sales which bases the sales promotion budget on a proportion of past or expected sales,[37/] (2) all you can afford, which generally sets the total sales promotion budget equal to a predetermined share of profits, (3) return on investment, which considers part of the sales promotion costs as a capital investment and determines these costs by equating the rate of return to that of other investments, (4) objective and task, which determines the budget's level based on that which is required to attain a set of predetermined objectives,[38/] and (5) competitive parity, which is used to maintain stability of the percentage of industry sales promotion allocated by each firm, that is, a firm tries to maintain its promotion level relative to that of the industry.

Formulation of current decision process.--The formulation in this study uses a variation of the percentage of sales approach, because it is simple to

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36/ Each method essentially assumes that any increase in the sales promotion budget has positive effects on revenues.

37/ Theoretically, sales promotion is used to increase demand for a firm's product above what it would otherwise be. Thus, it should be considered as the cause and not the result of sales. Furthermore, to the extent that future sales are affected by current sales promotion, the procedure is based on circular reasoning.

38/ Vague objectives are often unmeasurable and therefore unsuitable for this approach. Some vague objectives are keeping the company's name before the public, making customers easier to sell to, and carrying the sales message beyond the range of product distribution.

apply and likely to be used by bakers.[39/] The wholesalers' level of sales promotion ($\$_{promot}$) is affected by the quantities of bread allocated to each type of distribution outlet (Q_{dsws}, Q_{dshs}, Q_{drop}, Q_{dock}) and type of label (Q_{ob}, Q_{pl}).

Fortunately, the NCFM (27) data make it possible to separate the sales promotion costs associated with types of distribution outlets from those associated with types of labels.[40/] Sales promotion costs associated with distribution outlets include the selling deductions (for example, trade discounts and samples), advertising, and other promotion expenses. Costs associated with types of labels include the cost of packaging materials. Packaging may provide more than the utilitarian aspects of wrapping bread, because there are different types of wrappers--cellophane, waxpaper, and plastic--and the wrapper design carries an advertising message.

Two additional variables may also affect the level of advertising and promotion expenses. An aggressive (AGGR) baker may allocate more funds to sales promotion than other competitors. In addition, if the percentage of total revenue allocated to sales promotion by other firms (PCT^*_{sp}) in the market increases, then a particular firm may also increase its allocation.

But preliminary analysis indicated that AGGR, which was measured as the percentage of total sales a firm allocated to selling deductions, and PCT^*_{sp} were not important variables in determining the level of selling deductions,

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39/ A conference with officials from Quality Bakers of America indicated that this decision is a reasonable approximation of the many procedures used by bakers.

40/ Separating these variables is desirable, because the high intercorrelation between Q_{dsws} and Q_{ob} would cause the estimated parameter values to have extremely large sampling variances.

advertising, and other promotion. Such a situation could result if bakers are in a stable competitive-parity position, that is, bakers are not sales-pressure aggressive and the percentage of total revenue allocated to promotion activities is relatively constant.

Considered by itself, Q_{dshs} is not an important determinant of the level of sales promotion, perhaps because advertising and promotion is a joint effort for all types of outlets and because Q_{dshs} represented such a minor part of production. Rather than omit the variable, however, it was included with Q_{dsws}. As a result, subsystem 8.0 was formulated as:

Subsystem 8.0

$$(8.1) \quad \$_{pack} = \beta_{11}Q_{ob} + \beta_{12}Q_{pl} + U_1;$$

$$(8.2) \quad \$_{deduct} = \beta_{21}\ (Q_{dsws} + Q_{dshs}) + \beta_{22}Q_{drop} + \beta_{23}Q_{dock} + U_2;$$

$$(8.3) \quad \$_{promot} = \hat{\beta}_{21}\ (Q_{dsws} + Q_{dshs}) + \hat{\beta}_{22}Q_{drop} + \hat{\beta}_{23}Q_{dock} + \hat{\beta}_{11}Q_{ob} + \hat{\beta}_{12}Q_{pl};$$

where $U \sim N(0,\sigma_i^2)$; $(i=1,2)$.

Statistical estimation of behavioral parameters.--The parameters of subsystem 8.0 were estimated by least squares for the first two equations. The estimates of 8.3 were derived from the estimates of the previous equations by summing the parameter estimates across equations. Estimates of the parameters and other statistical information are shown in table 7.

Explanation of total variance is high for all equations, except for medium firms' deductions and promotion. This indicates that wholesale bakers do in fact use a mechanistic decision framework for determining sales promotion. These expenditures are proportional to output, and output is determined by maintaining market shares. The competitive-parity approach for determining the level of sales promotion would yield roughly the same degree of expenditure. Either procedure reduces the probability of advertising warfare.

Table 7--Expenditures for packaging material, selling deductions, advertising, and promotion allocated by baking firms based on labeling and distribution decisions

Type of sales promotion by kind of firm	$ [2/]	Coefficients for [1/] -- Q_{dsws} [3/]	Q_{drop}	Q_{dock}	Q_{stor}	Q_{ob}	Q_{pl}	R^2	$S_{\hat{y}}$
Small wholesale: (N=126)									
Packaging material	11.0					1.29*	1.58*	0.881	2.30
	(6.7)					(0.02)	(0.02)		
Deductions & promotion	22.7	2.87*	3.07*	1.24*				0.772	10.50
	(21.8)	(0.10)	(1.30)	(0.51)					
Sales promotion [4/]	33.7	2.87	3.07	1.24		1.29	1.58	0.886	10.70
	(22.8)								
Medium wholesale: (N=278)									
Packaging material	20.0					1.27*	1.32*	0.795	4.40
	(9.6)					(0.02)	(0.13)		
Deductions & promotion	43.7	2.68*	4.45*	2.65*				0.398	24.10
	(30.9)	(0.10)	(0.99)	(0.51)					
Sales promotion [4/]	63.7	2.68	4.45	2.65		1.27	1.32	0.566	24.50
	(32.4)								
Large wholesale: (N=102)									
Packaging material	38.9					1.24*	0.81*	0.856	7.00
	(18.4)					(0.02)	(0.28)		
Deductions & promotion	106.1	3.22*	1.88*	5.24*				0.623	50.61
	(81.5)	(0.16)	(1.23)	(0.61)					
Sales promotion [4/]	145.0	3.22	1.88	5.24		1.24	0.81	0.704	51.10
	(83.6)								
Chain store: [5/]									
Packaging material	21.5						1.32		
Deductions & promotion	70.9		4.45		2.65				
Sales promotion [4/]	92.4		4.45		2.65		1.32		

1/ Coefficients significantly different from zero at the 5-percent level are denoted by *. Standard errors of the estimates are in parentheses.

2/ Mean values of the expenditures are reported in ten thousands of dollars per year. Standard errors are in parentheses.

3/ The parameter values are found by adding those of packaging materials to those of selling deductions, advertising, and promotion. The coefficient of determination (R^2) is found by calculating the proportion of squared errors explained in total sales promotion, given the parameters estimated by separate regressions.

4/ Estimates are based on the assumption that the chain store baker is the same size and has behavior similar to that of medium size wholesalers with respect to the types of labels and outlets open to the chain store baker. Mean values of expenditures are found by multiplying per unit costs by mean quantities shown in Tables 4.1 and 4.2 and by summing.

5/ Q_{dsws} in this case only also includes Q_{dshs}.

The coefficients of Q_{ob} remain relatively constant for all sizes of firms, but the coefficients of Q_{pl} decrease as the size of firm increases. This may indicate economies of scale in obtaining wrappers for private label bread. Alternatively, it may indicate a greater market power for larger firms, because some of the larger bakers may require the purchaser to supply his own wrapper.

All of the coefficients on quantities by type of distribution outlet are positive. And most are significantly different from zero at the 5 percent level. It is difficult to analyze their relative magnitudes, because there does not seem to be any consistent pattern among them. But the corresponding parameters of the administrative and distributive cost functions have an offsetting pattern. Thus, the relative magnitudes of the parameters will be discussed in terms of the total cost function.

Supermarket behavior was assumed to be similar to that of medium wholesalers. In this decision framework, supermarket bakers could only package private label bread because of their restricted production pattern. Similarly, they were restricted to drop-stop delivery or baked at the store. It was assumed that the parameter associated with Q_{dock} would be applicable to Q_{stor}. These behavioral parameters have the same limitations as in the previous subsystems.

Consumer Demand

Classical demand theory provides a basis for formulating a market demand function for bread. In general terms, the quantities of a commodity that a consumer demands are a function of the prices of all commodities and his income (17). Most prior analyses concerning this commodity area have focused on the demand for wheat products, but more recent studies have focused on the nature of the demand for bread and related products.

Meinken (24) used single equation methods to estimate the retail price and income elasticities of demand for bread, rolls, and coffee cake. Estimates were

based on Census of Manufacturers data for intermittent years from 1923 to 1947. The equation was fitted with per capita consumption as a function of price, per capita disposable income, and a time variable. At the means, the results indicated a price elasticity of demand for bread of -0.6 and an income elasticity of 0.4. But none of Meinken's coefficients were statistically significant.

Rockwell (34) used cross-section consumer household data to estimate separate income elasticities associated with different levels of income. His estimates consistently decline as the level of income increases as shown by his estimates of 0.20 for low income groups and -0.08 for high income levels.

Brandow (5, p. 38) did not estimate directly the price elasticity for bread, flour, and prepared cereals. He used a figure of -0.15 as "a rough estimate, but it cannot be far wrong in absolute terms." He further specified the income elasticity to be zero. George and King (14) adopted the same assumptions.

Formulation of market demand behavior.--Bread has no real substitute nor complement. Brandow's (5, p. 17) estimates of cross elasticities for other types of foods show that bakery products are substitutes in every case. But the largest of these cross elasticities is with beef, and it is only 0.03. Such a small cross effect indicates that substitutes may be ignored in a single equation model.

The model used in this study has been reported in detail (25). Monthly per capita demand for bread ($\overline{CD}_t$) was formulated as a first order autoregressive function of its own price (P_t), of per capita disposable income (Y_t), and of the cyclical variation represented by sin θt and cos θt,[41] where θ equals 30 degrees (0.5236 radians), because each month represents 360/12 degrees ($2\pi/12$

41/ The sine and cosine variables are needed to estimate the amplitude $\sqrt{(b_3)^2 + (b_4)^2}$ of the cycle and the phase angle arctan $\left[\frac{b_3}{b_4}\right]$; where b_3 and

(Footnote continued on page 50)

radians) of the total cycle, and $t=1,2,\ldots,12$. θ is multiplied by t to obtain the argument of sine and cosine. Quantity is a function of price (and not the reverse), because price is set by the industry and consumers adjust quantity demanded to this price. Bread which is not sold by a baking company is returned as "stales" and is disposed of in thrift stores, stuffing mixes, and other ways. Total market demand (CD_t) equals $\overline{CD}_t$ times population (POP_t). Thus, market demand was represented as:

Subsystem 2.0

$$(2.1) \quad \overline{CD}_t - \rho\overline{CD}_{t-1} = a(1-\rho) + b_1 (P_t - \rho P_{t-1}) + b_2(Y_t - \rho Y_{t-1})$$
$$+ b_3 \sin \theta t + b_4 \cos \theta t + U;$$

where ρ is the autocorrelation coefficient; $U \sim N(0,\sigma^2)$; and

$$(2.2) \quad CD_t = \overline{CD}_t * POP_t$$

Market demand parameters.--The market's consumer demand function was estimated (25) as $\overline{CD}_t = 4.393 - 12.08\, P_t + 0.0034\, Y_t - 0.0483 \sin \theta t - 0.1105 \cos \theta t$ where the autocorrelation coefficient had a value of 0.4455. The parameters are all highly significant. Monthly consumption figures of bread and bread type rolls were developed by applying industry production indices (1) to the quantity produced in 1963 (45). Retail prices of white pan bread were obtained from reports on food prices (50). Monthly disposable income figures were generated from surveys of business (48). Consumption and disposable income

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(Footnote 41 continued)

b_4 are the estimated coefficients of $\sin \theta t$ and $\cos \theta t$, respectively. Estimates of these two elements are used to combine the sine and cosine variables into a single variable as $\sqrt{(b_3)^2 + (b_4)^2} \cos \left[\theta t - \arctan \frac{b_3}{b_4}\right]$ to represent fluctuation (9, p. 347).

were placed on a per capita basis by dividing by civilian population (47). Prices and income were both deflated to 1958 levels based on indices (49).

The yearly consumption cycle was represented by the trigonometric variables. These variables were combined into one variable: $-0.1188 \cos (0.5236t - 0.415)$. Holding other things constant, this relationship was used to determine the minimum of the cycle, that is, where $\cos (X) = -1.0$; and also the maximum of the cycle, that is, where $\cos (X) = 1.0$. Thus, minimum per capita consumption occurs about mid-January, and maximum per capita consumption about mid-July.[42/] Such results were expected, because sandwiches are used at picnics in the summer.

The elasticities are reported at the means. Price is inelastic (-0.372) as expected.[43/] A 10 percent increase in price would be associated with a 3.7 percent decrease in bread consumption. Income is very inelastic (0.086). A 10 percent increase in per capita disposable income would be associated with only an 0.86 percent increase in consumption. Thus, the demand for bread is somewhat price responsive but nearly unresponsive to income changes.

Formulation of product demand behavior.--Traditional demand theory considers that commodities are homogeneous, that is, all items in a commodity group are assumed to be equally satisfying to a consumer. But it may not be true that one brand of bread is an satisfying to a consumer as another brand. Higgins (18, p. 469) defined commodity as a group of products (brands) which is "technically" the same and product (brand) as an identifiably differentiated commodity. Within this framework, the baking industry produces a bread and bread-type roll

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42/ This allows integer values of t to lie at the midpoint of each month.

43/ Price elasticities at two standard deviations from the mean slope are -0.254 and -0.490.

commodity, while firms within the industry produce products differentiated by brand. The market demand curve, formulated in the previous section, represents demand for the industry's commodity. But demand for a firm's brand must also be formulated. In other words, the decision process for the allocation of this commodity demand to firms' brands must be examined, that is, market share functions.[44/]

Brand demand response to price changes for competing goods differs from the total demand response. Consumer indifference curves for two competing commodities usually show that as their relative prices change, consumers substitute some of the relatively cheaper commodity for the other commodity. But some researchers feel that the only admissible type of consumer indifference curve for technically similar products (brands) is a straight line (37, pp. 12-15); that is, the rate of substitution between products in the same commodity must be constant (32, p. 406). If brand prices change sufficiently, consumers would substitute the relatively cheaper brand for the other brand. Hence, there may be theoretical as well as practical reasons why bakers are not price competitors. Since price is basically the same for all brands of bread, it is not important in allocating market demand to different firms.

Sales promotion (including advertising, promotion, sales deductions, and type of wrapping), affects consumer allocation of commodity demand among firms' brands. If consumer indifference curves are identical with the price line, sales promotion can cause consumers to consistently purchase more of a particular firm's brand. Similarly, promotion may be designed to alter the linear indifference curves postulated by Schnabel. This eliminates the concept of perfect

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44/ The problem of allocating a firm's share of market demand for bread and bread-type rolls to his output by type of distribution outlet has been considered previously.

substitution in the mind of the consumer. Thus, sales promotion can reduce the random choice patterns of consumers.

Schnabel (37, p. 17) assumed that the consumer preference function is homogeneous of degree zero with respect to all sales promotion. That is, if all firms increased their sales promotion expenditures proportionately, consumers would not alter the brand mix. Thus, a firm's market share depends on relative sales promotion rather than on absolute levels of sales promotion for each firm.

The number of firms in a market might be expected to negatively affect a firm's market share. Presumably, such an effect would have a covariate effect with size of firm. Consequently, for wholesale bakers three variables were formulated--number of small wholesalers (NSW), number of medium wholesalers (NMW), and number of large wholesalers (NLW).

The size of the firm in question may also affect its market share. A small firm probably has a smaller market share intercept than a medium firm, and a medium firm probably has a smaller intercept than a large firm. So, market share was assumed to shift with the size of firm--small (S), medium (M), and large (L). These variables are used as qualitative factors in the estimation procedure and take on values of 0 and 1. The intercept was omitted, because the shift variables already take account of it.

Chain stores are not included in this market share function, because data concerning their sales promotion activities was not available. For simplicity, chain stores (in aggregate) are considered to maintain their part of the market, that is, 11.6 percent. This part is divided evenly among the number of chain stores (NSM) in the model. Even though retail bakers are not an integral part of the model, they also are assumed to maintain their part of the market, that is, 7.6 percent. So, the remaining 80.8 percent of the market is allocated among the wholesale bakers. Since the sum of the regressed market shares (MS*) may not

equal 0.808 in a given market, each wholesale firm's market share (MS) is normalized with respect to all wholesale firms (NWF).

The market share functions of subsystem 9.0 are formulated as:

<u>Subsystem 9.0</u>

(Wholesale firm's market shares)

$$(9.1) \quad MS^* = d_1S + d_2M + d_3L + b_1NSW + b_2NMW + b_3NLW + b_4 \frac{SP}{SSP} + U; \text{ where } U \sim N(0,\sigma^2);$$

$$(9.2) \quad MS_i = \frac{MS^*}{\sum_{i=1}^{NWF} MS_i^*} * 0.808;$$

(Chain store's market shares)

$$(9.3) \quad MS = 0.116/NSM.$$

In the simulation model, firms may underproduce for their respective share of the market, that is, QP is less than quantity demand for their brand (PD). This may happen for two reasons. First, ex ante demand for bread and bread-type rolls is less than ex post demand. Second, ex ante market shares are less than ex post market shares. The excess demand is allocated proportionately to other wholesale bakers on the basis of their respective market shares.

On the other hand, firms may find that they have overproduced (OP) for their respective share of the market. This may happen if ex ante values of market demand and market share are greater than their ex post values and if other firms have not underproduced sufficiently to permit sales (QS) of the brands in excess supply. Overproduction (unsalable stales) increases the per unit cost of a firm's quantity sold. These relationships may be represented as:

(Each firm's product demand, quantity sold, and overproduction)

$$(9.4) \quad PD = MS * CD_t;$$

$$(9.5) \quad QS = \begin{cases} PD \text{ if } Q'' > PD \\ Q'' \text{ if } Q'' < PD, \end{cases}$$

$$(9.6) \quad OP = \begin{cases} Q'' - PD \text{ if } Q'' > PD \\ 0 \text{ otherwise} \end{cases}$$

(Allocation of a firm's underproduction to firms with excess supply)

$$(9.7) \quad \Delta PD_j = \min \left[OP_j; \frac{MS_j}{\sum_{k=1}^{NWF} MS_k} * |OP_i| \right] \text{ for } k \neq h \text{ where } OP_h < 0.$$

Statistical analysis of market share parameters.--A baking firm's relative sales promotion is an important variable associated with its market share (see table 8). In fact, if a firm could increase its sales promotion share by 10 percent, holding actions by other firms constant, it would increase its market share by 6.8 percent. However, other firms would probably respond by increasing their sales promotion budgets thus diluting the effectiveness of sales promotion for the initiating firm. In an escalating situation, firms are faced with increasing sales promotion expenditures without the benefit of increasing sales.

The effects of the number of firms by size grouping are significantly different from zero and have the expected negative signs. The predictive equation shows that when an additional firm enters the market, a medium sized firm will reduce the market share of an established firm by twice that of an entering small firm (-0.0050 to -0.0023). An additional large firm has three times the negative effect of an entering small firm (-0.0075 to -0.0023).

The intercepts by size of firm show the expected relationship, that is, they increase as size of firm increases. These parameters are significantly different from zero and are also significantly different from each other.

Explanation of total variance is high (0.849). More importantly, this simple equation can predict a firm's percentage market share with a standard deviation of 3.2 percent.

Table 8--Market share parameters of wholesale bakers related to allocation of demand for bread and bread-type rolls

		Coefficients for 1/ --								
MS 2/	N	S	M	L	NSW	NMW	NLW	$\frac{SP}{SSP}$	R^2	$S_{\hat{y}}$
0.123	456	0.062*	0.081*	0.110*	-0.0023*	-0.0050*	-0.0075*	0.679*	0.849	0.032
(0.081)		(0.008)	(0.008)	(0.010)	(0.0009	(0.0008)	(0.0011)	(0.024)		

1/ Coefficients significantly different from zero at the 5-percent level are denoted by *. Standard errors of the estimates are in parentheses.

2/ The mean market share is shown as a proportion. The standard error is in parentheses.

Revenues

Revenues are determined by the prices and quantities sold through distribution outlets. Thus a firm's output by type of distribution outlet can be used in deciding how to allocate a firm's share of the market demand for bread and bread-type rolls. Since supply has already been allocated in subsystem 5.0, quantity sold can be determined.

Bread which is sold through drop stop or dock pickup is usually produced on contract. And demand for these outlets is known. Bread which is sold through driver-salesperson wholesale, is delivered on a consignment basis, consequently, its ex ante demand estimate is not certain. Likewise, demand for bread delivered through driver-salesperson home service is stochastic. If there is any overproduction (OP), it is allocated to only these home service outlets since the other outlets involve contracts. The allocation of overproduction is in proportion to the production for these outlets. Hence, revenues are calculated as:

Subsystem 10.0

$$(10.1) \qquad \$_{rev} = P_{dsws}\left[Q_{dsws} - \left(\frac{Q_{dsws}}{Q_{dsws} + Q_{dshs}}\right) *OP\right] + P_{dshs}\left[Q_{dshs} - \left(\frac{Q_{dshs}}{Q_{dsws} + Q_{dshs}}\right) *OP\right] + P_{drop}*Q_{drop} + P_{dock}*Q_{dock} + P_{stor}*Q_{stor};$$

where $\$_{rev}$ denotes total revenue, the prices (P_{dsws} etc.) are determined in subsystem 1.0, the quantities available for sale by type of outlet (Q_{dsws} etc.) are determined in subsystem 5.0. Overproduction is determined in subsystem 9.0. Subsystem 10.0 is used to calculate revenues for chain stores as well as wholesale bakers since zeroes appear in the appropriate quantity positions.

Cost Functions

The formulated cost functions take into account the decision variables generated in the behavioral decision processes. The estimated parameters provide information concerning costs by types of bread labeling, distribution outlets, production process, or ingredient handling. A cost function is developed for each relevant decision center (subsystem). Then these functions are summed to obtain the total cost functions. Cost functions are developed for ingredients acquisition which is affected by the method of ingredient handling for manufacturing which is affected by the type of production process, and for administration and distribution which are affected by the types of distribution outlets. Costs for sales promotion are developed in two ways. One is for packaging materials and is affected by types of bread labeling. The other is for advertising, promotion, and sales deductions, and it is affected by types of distribution outlets. This procedure is valid if the costs for each decision center are additive, that is, independent.[45/]

Subtotal cost functions are formulated in linear form without an intercept. In some cost categories, the accounting data compiled by the NCFM were in the form of direct, or variable, costs allocated to the various firm operations. Because in these cases the fixed costs were not developed, the estimated functions were restrained to show zero costs with zero output. In other cases the initial estimates of the cost functions resulted in insignificant or negative intercept terms. Hence, the intercepts were then restrained to be zero. Thus, economies of scale are not apparent within a particular size range of firms. But

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45/ Preliminary analysis indicated that bakers' cost patterns do not violate this procedure. The analysis was done by estimating an equation for advertising, promotion, and sales deductions with administrative and distribution costs. The parameters do not differ appreciably from those estimated by summing separate functions.

separate functions for the various size ranges permit differentiation of relative costs by size groups.

Choice of the cost functions form must be considered carefully. An inherent problem of projecting results of any regression analysis is the lack of certainty that the true slopes have been detected. The presence of multicollinearity may make it possible for several different functional forms to have high R^2 and yet have widely differing slopes (41).

The linear functions used in this study should not present an insurmountable problem for projection purposes because the sizes of firm delineations are distinct. Also, the regressed total cost functions are "expected" average cost curves rather than "true" economies of scale curves, and most importantly the range of firm output is very wide, that is, from about 10 thousand pounds of bread per week to 1,400 thousand pounds. So if a firm increases (decreases) its output and this puts the firm in a larger (smaller) size category, its expected costs can be developed.

Ingredient costs.--These costs are largely affected by the quantity of flour used and by type of ingredient handling (55, pp. 161-164). Hence, a simple ingredient costs function was formulated as:

$$\text{(11.1)} \quad \$_{ingred} = b_1 Q_{bulk} + b_2 Q_{bags} + U;$$

where $\$_{ingred}$ denotes the total cost of ingredients; the other variables are as defined previously, and $U \sim N(0, \sigma^2)$.

Explanation of total variance (table 9) is uniformly high, ranging from 0.860 for medium wholesalers to 0.967 for small wholesalers. Thus, this formulation reasonably represents the costs of ingredients.

Bulk handling is generally a more efficient method of ingredient handling than bag handling.46/ In this regression analysis, small and medium firms could

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46/ Walsh and Evans (55, pp. 161-164) reported that bulk handling would have saved all sizes of wholesale firms 0.64 cents per pound of bread produced in 1959 when compared with bag handling.

Table 9--Cost parameters of baking firms related to cost of ingredients, manufacturing, administration, and distribution; and current behavioral parameters related to amount of money allocated to sales promotion

Type of cost by kind of firm	\$[2/]	Coefficients for[1/]--												
		Q_{dsws}	Q_{dshs}	Q_{drop}	Q_{dock}	Q_{stor}	Q_{ob}	Q_{pl}	Q_{bulk}	Q_{bags}	CNTL* Q_{manu}	CNTS* Q_{manu}	R^2	$S_{\hat{y}}$
		Cents per pound												
Small wholesale: (N=126)														
Ingredient	42.3								7.96*	8.63*			0.967	4.4
	(24.4)								(0.10)	(0.10)				
Manufacturing	29.4										3.64*	2.86*	0.813	9.2
	(21.2)										(0.09)	(0.35)		
Administration and distribution	41.6	4.61*	10.31*	3.88*	4.01*								0.915	8.0
	(27.0)	(0.08)	(1.26)	(0.99)	(0.39)									
Sales promotion[3/]	33.7	2.87	2.87	3.07	1.24		1.29	1.58					0.856	10.7
	(22.8)													
Total cost[4/]	147.0	7.48	13.18	6.95	5.25		1.29	1.58	7.96	8.63	3.64	2.86	0.955	16.8
	(48.0)													
Medium wholesale: (N=278)														
Ingredient	79.8								8.02*	8.27*			0.860	13.9
	(37.2)								(0.09)	(0.19)				
Manufacturing	52.4										3.45*	3.14*	0.753	13.0
	(26.0)										(0.06)	(0.08)		
Administration and distribution	77.7	5.00	8.05*	2.02**	5.16*								0.851	15.2
	(39.1)	(0.06)	(1.15)	(0.63)	(0.32)									
Sales promotion[3/]	63.7	2.68	2.68	4.45	2.65		1.27	1.32					0.566	24.5
	(32.4)													
Total cost[4/]	273.6	7.68	10.73	6.47	7.81		1.27	1.32	8.02	8.27	3.45	3.14	0.901	34.5
	(68.1)													
Large wholesale: (N=102)														
Ingredient	161.2								8.63*	8.46*			0.890	27.1
	(81.2)								(0.15)	(0.33)				
Manufacturing	102.2										3.31*	2.91*	0.771	25.2
	(52.5)										(0.08)	(0.17)		
Administration and distribution	178.3	5.32*	9.54*	5.57*	2.96*								0.815	42.0
	(95.9)	(0.14)	(0.83)	(1.02)	(0.51)									
Sales promotion[3/]	145.0	3.22	3.22	1.88	5.24		1.24	0.81					0.704	51.1
	(83.6)													
Total cost[4/]	586.7	8.54	12.76	7.45	8.20		1.24	0.81	8.63	8.46	3.31	2.91	0.898	75.8
	(159.8)													
Chain store:[5/]														
Ingredient	79.8								8.02	8.27				
Manufacturing	52.4										3.45	3.14		
Administration and distribution[6/]	42.3			2.02		5.16								
Sales promotion[3/]	92.4			4.45		2.65		1.32						
Total cost[4/]	266.9			6.47		7.81		1.32	8.02	8.27	3.45	3.14		

1/ Coefficients significantly different from zero at the 5 percent level are denoted by * and at the 10 percent level by **. Standard errors of the estimates are in parentheses.

2/ Mean values of the expenditures are reported in ten thousands of dollars per year. Standard errors are reported in parentheses.

3/ The parameter values are derived in table 4.

4/ The parameter values are found by adding those of ingredients, manufacturing, administration, and distribution to those of sales promotion. The coefficient of determination (R^2) is found by calculating the proportion of squared error explained in total costs, given the parameters estimated in separate regressions.

5/ Estimates are based on the assumption that the size of the chain store baker is the same as that of the mean medium wholesale baker, has behavior similar to that of medium wholesalers, and has a cost structure similar to that of medium wholesalers with respect to the types of labels and distribution outlets open to the chain store baker.

6/ Mean value of expenditures was found by multiplying per unit costs by mean quantities shown in appendix table 3.

save 0.67 and 0.25 cents per pound of flour handled by using bulk handling (table 9). This table also indicates that large firms may not have operated at the minimum points of their shortrun average cost curves. Another possibility for error lies in the data. Bakers reported total cost of ingredients and quantities of white bread-type flour by method of ingredient handling (27, pp. 149-151). If they produced large quantities of whole wheat, cracked wheat, rye, and other types of bread which contain no white bread-type flour, then the reported figure is an underestimate of flour used. Consequently, the cost parameters are overestimated.

On the other hand, the cost of input per unit of output as opposed to the cost of input per unit of input eliminates the data definition problem and shows more reasonable results. Multiplying the yield parameters in table 6 by the respective ingredients cost parameters in table 9 gives costs of ingredients by method of ingredient handling per pound of bread manufactured. These results are shown in table 10. If the standard errors are taken into account, the data indicate little difference in efficiency by method of ingredient handling.

As shown previously, the cost functions for medium wholesale bakers were used to obtain parameters applicable to chain store bakers.

Manufacturing costs.--These costs depend largely on the quantity of bread manufactured. Walsh and Evans (55, pp. 161-164) showed that adoption of continuous mix may greatly affect costs. Use of capacity was found not to be an important variable in determining total costs of manufacturing, because its parameters were not significantly different from zero for all firm sizes. The simple manufacturing cost function was represented as:

$$(11.2) \quad \$_{manu} = b_1 CNTL{*}Q_{manu} + b_2 CNTS{*}Q_{manu} + U;\ U \sim N(0,\sigma^2).$$

Explanation of total variance (table 9) is satisfactory, ranging from 0.753 for medium firms to 0.813 for small firms.

Table 10--Ingredient costs per pound of bread produced by method of ingredient handling for wholesale bakers[1]

Size of wholesale baker	Method of ingredient handling	
	Bags	Bulk
	--------Cents-------	
Small	5.17	4.77
Medium	5.15	5.04
Large	4.92	5.02

1/ These estimates were obtained by multiplying the pounds of flour per pound of bread in table 6, that is, the coefficient on Q_{manu}, by the respective cost per pound of ingredient by method of handling in table 9.

Continuous mix is more efficient for all firm sizes. In this regression analysis, small, medium, and large firms would save 0.78, 0.31, and 0.40 cents per pound of bread produced by switching to continuous mix. The results are supported by an earlier engineering study (55).

Chain store bakers' manufacturing cost function parameters were set equivalent to those of medium wholesalers.

Administrative and distribution costs.--These costs include costs of executive salaries, delivery employee salaries and commissions, truck expenses, and so forth, and are largely affected by the choice of distribution outlets. Distribution costs obviously are associated with types of outlets. Administrative costs, however, are jointly sustained by all the decision centers--labeling, ingredient handling, manufacturing, distribution, and sales promotion. Furthermore, quantities associated with the various decision centers are highly correlated. In this study, the administrative costs were included with distribution costs, since distribution incorporates the quantities flowing through the other decision centers. It does preclude, however, evaluation of the effects on administrative costs of changes in labeling, production process, or ingredient handling methods. The administrative and distribution cost function for wholesale bakers was represented as:

$$(11.3) \quad \$_{admin} = b_1Q_{dsws} + b_2Q_{dshs} + b_3Q_{drop} + b_4Q_{dock} + U;$$

where $\$_{admin}$ denotes total costs of administration and distribution; the other variables are defined previously, and $U \sim N(0,\sigma^2)$.

Explanation of total variances, R^2 (table 9), is uniformly high--0.815 for large firms to 0.915 for small firms. Thus, this formulation does reasonably represent the total costs of administration and selling.

Driver-salesperson home service is the most costly outlet for all firm sizes, requiring 3 to 5 cents more for administrative and distribution costs per pound of

bread than any other outlet. Such results are expected because of the low volume routes associated with home delivery.

Driver-salesperson wholesale is somewhat less costly for small firms than for either medium or large firms. This increased efficiency of small firms likely results from their smaller delivery route systems. Medium and large firms may make greater use of depots, which increases distribution costs. But their increased volume probably causes offsetting efficiencies in manufacturing. Because data is lacking, the administrative and distribution functions do not include geographic and demographic considerations which may affect costs of distribution. Thus, to draw conclusions about the relative efficiencies among firms regarding only administrative and selling costs for Q_{dsws} would be erroneous.

The cost parameters of the other two types of outlets are difficult to explain, because there is no consistent pattern among them. Since the corresponding parameters of the sales promotion behavioral function have an offsetting pattern, their relative magnitudes will be discussed later with the total cost function.

Chain store bakers' parameters of administrative and selling cost functions were developed from those of medium wholesalers. Zero cost parameters are inserted for outlets not applicable to chain stores. The Q_{stor} parameters is derived in a manner similar to its parameters estimate in the sales promotion behavioral function, that is, the cost parameters for Q_{dock} for medium wholesalers is assumed to be an appropriate estimate of the parameter for Q_{stor} for chain stores.

<u>Total costs</u>.--This function is equal to the sum of ingredient costs, manufacturing costs, administration and distribution costs, and sales promotion expenditures. The only addition of parameter estimates required is with respect to quantities by type of distribution outlet for the administrative and distribution costs and sales promotion expenditures. An analysis of these total cost

function parameters does not negate any of the earlier analysis for Q_{dsws} or Q_{dshs}. But the summation tends to eliminate some of the problems in explaining relative magnitudes of the parameters for Q_{drop} and Q_{dock}. Small firms have per unit costs for Q_{dock} (5.5 cents) which are less than those for Q_{drop} (6.95 cents). This seems likely since dock pickup has none of the transportation costs involved in multiple drop-stop deliveries.

Medium and large firms' relative magnitudes for Q_{dock} (7.81 and 8.20 cents) and Q_{drop} (6.47 and 7.45 cents) are contrary to the expected relationships. One possible explanation is that medium and large firms use independent jobbers who buy bread at the bakers' dock and distribute it on routes (39, p. 119). In this situation, wholesalers may provide per unit discounts according to the magnitude of their distribution costs for Q_{dsws}. They may also advertise or promote at a similar rate. This may explain why the magnitude of the parameter for Q_{dock} for medium and large firms is similar to that for Q_{dsws}. Furthermore, if the standard errors are taken into account, these differences may not be so significant.

Profit and Loss Functions

Profit is a positive difference between revenues and costs. Loss is a negative difference, and of course entrepreneurs attempt to avoid it.

Bakers may be interested in several performance characteristics of their individual activities and those of the market. The characteristics chosen for individual bakers in this study are, for each unit, their sales promotion expenditures (ASP), total costs (AC), revenues (AR), and profits (π). The variable of interest in the market is the industry per unit profit (π_{ind}). These accounting equations are represented as:

Subsystem 12.0

(12.1) $ASP = \$_{promot}/Q''$;

(12.2) $AC = \$_{costs}/Q''$;

(12.3) $AR = \$_{rev}/Q''$;

(12.4) $\pi = AR - AC$; and

(12.5) $\pi_{ind} = \sum_{i=1}^{NWF} (\$_{rev} - \$_{costs}) / \sum_{i=1}^{NWF} Q''$.

MODEL VALIDATION

Many methods have been proposed for judging how well a model compares to its counterpart--the real system. All methods have the same, broad, null hypothesis that the difference between a model's output and that of the real system is not discernible. A model that has a single endogenous variable is generally validated by comparing the model's output with the actual values of that variable in the real system.

Systems models pose an additional validation problem, because output from such models is usually multidimensional. In table 11, 16 endogenous variables are generated for each wholesale firm in the market.

Little progress has been made in developing meaningful comparisons of multidimensional output. One attempt to analyze multiple response situations used concepts developed in utility theory (29, p. 1334). This theory provided a basis for assigning weights to variables corresponding to the entrepreneurs' order of importance. But it is difficult to assign a nonarbitrary weighting pattern.

Measures of "goodness of fit," which are used to verify the model, are not strictly multidimensional. But if each output variable is tested independently and if all of these are compared as a group, then the measure of the model has validity. Some subjective comparisons among the variables and the real system (28, pp. 1351-1352) are exact matching of the variables, average values of the variables, variation about the means, and probability distributions.

Table 11--Actual output of a sample market by wholesale firm for 1960 and 1964, and differences

Comparisons by size of firm and code	Q''	MS	OP	Q_{ob}	Q_{pl}	Q_{dsws}	Q_{dshs}	Q_{drop}	Q_{dock}	Q_{bags}	Q_{bulk}	CNTS* Q_{manu}	SP	REV	COSTS	PROFIT
	Million pounds	Percent											Cents per pound			
1960 data:																
Small																
9114	0.293	3.2		19.3	80.7	67.6	0.0	0.0	32.4	100.0	0.0	0	2.4	21.0	20.8	0.2
64114	0.229	2.5		100.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0	2.7	18.2	16.4	1.8
Medium																
16214	1.086	11.7		100.0	0.0	100.0	0.0	0.0	0.0	16.5	83.5	0	4.6	19.5	18.9	0.6
68214	0.938	10.1		99.9	0.1	51.5	46.1	2.3	0.1	100.0	0.0	0	3.1	20.6	20.1	0.5
74214	1.809	19.6		97.4	2.6	91.5	5.5	3.0	0.0	14.0	86.0	100	3.3	17.4	16.3	1.1
Large																
222314	3.120	33.7		100.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	0	3.7	20.1	18.4	1.7
1964 data:																
Small																
9114	0.368	3.8		6.6	93.4	87.3	0.0	0.0	12.7	100.0	0.0	0	4.2	21.0	19.8	1.1
64114	0.195	2.0		100.0	0.0	100.0	0.0	0.0	0.0	15.0	85.0	0	2.3	18.3	16.2	2.1
Medium																
16214	0.970	10.0		91.6	8.4	91.5	0.0	0.0	8.5	15.8	84.2	0	4.5	21.0	20.1	0.9
68214	1.132	11.7		92.2	7.8	46.2	45.7	7.9	0.1	6.3	93.7	0	3.3	20.0	18.5	1.5
74214	2.119	21.9		84.5	15.5	51.9	3.8	44.3	0.0	13.3	86.7	100	5.5	20.9	19.2	1.7
Large																
222314	3.040	31.4		100.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	0	4.2	20.7	18.8	1.9
Differences:																
Small																
9114	0.075	0.6		-12.7	12.7	19.7	0.0	0.0	-19.7	0.0	0.0	0	1.8	0.0	-0.9	0.9
64114	-0.034	-0.5		0.0	0.0	0.0	0.0	0.0	0.0	-85.0	85.0	0	-0.4	0.1	-0.2	0.3
Medium																
16214	-0.116	-1.7		-8.4	8.4	-8.5	0.0	0.0	8.5	-0.7	0.7	0	-0.2	1.5	1.2	0.3
68214	0.194	1.6		-7.7	7.7	-5.2	-0.4	5.6	0.0	-93.7	93.7	0	0.1	-0.6	-1.6	1.0
74214	0.310	2.3		-12.9	12.9	-39.6	-1.7	41.3	0.0	-0.7	0.7	0	2.3	3.5	2.9	0.6
Large																
222314	-0.80	-2.3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.5	0.6	0.4	0.2

Several analytical techniques have been developed to provide information regarding the "goodness of fit" on individual variables. Regression analysis and Chi-square tests provide a statistical comparison of the exact matching of the predicted variables to their actual values. Total variance analysis provides a statistical comparison of the output's variance.

Nonparametric tests compare the distribution of the variables. For example, a sign test can determine the correspondence between the number of simulated and actual observations above and below their respective means.

A nonstatistical procedure may also be used in validation. In this procedure, careful examination of the model is made to determine if it corresponds to the real system as well as to economic theory. The use of this criterion is often painstaking and tedious, and its significance depends on the examiners knowledge of an experience with the economics of the real system.

Two methods of validation were used on the baking industry model. Regression analyses are made for the levels of the output variables as well as a change in those levels from 1960 to 1964. This analysis regresses the actual observations on the simulated observations of the same variable, that is, $X_{actual} = a + bx_{simulate}$. An exact matching of these observations would yield a 45 degree line through the origin, that is, $X_{actual} = X_{simulate}$ (null hypothesis). Consequently, F-tests are used to determine if there are significant differences between the null hypotheses and the regressed lines (alternative hypotheses). The test is in form:

$$F = \frac{SSE_{\Omega} - SSE_{\omega}/df_{\Omega} - df_{\omega}}{SSE_{\Omega}/df_{\Omega}}$$

where SSE_{Ω} = the sum of squared error of the null hypothesis, that is, $\Sigma(X_{actual} - X_{simulate})^2$; SSE_{ω} = the sum of squared error of the alternative hypothesis, that is, $\Sigma(X_{actual} - a - bX_{simulate})^2$; df_{Ω} = degrees of freedom for the null

hypothesis, that is, N; and df_{ω} = degrees of freedom for the alternative hypothesis, that is, N-2.

The baking industry shows little change over time. Table 11 gives firms' actual output values and levels of the variables for one of the markets showing a large degree of change as reported by the NCFM. These results are compared for 1960 and 1964 in terms of first differences. Such a comparison indicates that a firm's greatest change comes when it adopts bulk handling of ingredients or continuous mix. Since trend relationships were estimates for these technology adoption processes, the simulation model should be equipped to represent outcomes in the baking industry as it changes from one situation to another.

In order to validate the model, the computer program used initializing values determined for each firm in 1960 for the market shown in table 11. The decision processes were estimated without use of the random error terms, because the goal in this case was to predict behavior in a single market. The results were generated and compared to the actual values for 1964. The simulated output is shown in table 12.

Levels of Variables

The validation procedure compares the levels on a group of variables associated with each decision center, for example, Q_{ob} and Q_{pl} for the labeling decision center. Thus, the procedure validates outcomes of a subsystem rather than individual variables in that subsystem.

The first two variables, quantity sold (QS) and market share (MS), indicate that the output of the model reasonably matches that of the real system (table 13). The calculated F-tests are 0.387 and 0.330, but the tabular value for two and six degrees of freedom and 5 percent level of confidence is 5.14. Thus, the null hypothesis shows no difference between the model's projection of QS and MS and those of the real world, and it cannot be rejected.

Table 12--Simulated output of a sample market by wholesale firm for 1960 and 1964, and differences

Comparisons by size of firm and code	Q"	MS	OP	Q_{ob}	Q_{pl}	Q_{dsws}	Q_{dshs}	Q_{drop}	Q_{dock}	Q_{bags}	Q_{bulk}	CNTS* Q_{manu}	SP	REV	COSTS	PROFIT
	Million pounds	-------	-------	-------	-------	Percent	-------	-------	-------	-------	-------	-------	------	Cents per pound	------	------
1960 data:																
Small																
9114	0.284	3.2		83.4	16.6	57.0	0.0	0.0	43.0	86.9	13.1	0	3.5	16.5	16.6	-0.1
64114	0.222	2.5		92.0	8.0	100.0	0.0	0.0	0.0	86.9	13.1	0	4.2	19.0	17.6	1.4
Medium																
16214	1.054	11.7		97.3	2.7	89.0	0.5	0.0	10.5	7.5	92.5	0	3.9	18.4	17.5	0.9
68214	0.910	10.1		92.2	7.8	47.3	34.5	10.1	8.0	69.8	30.2	0	3.2	20.1	17.6	2.5
74214	1.755	19.6		91.9	8.1	73.4	18.8	7.7	0.0	7.5	92.5	100	3.6	19.8	17.2	2.6
Large																
222314	3.024	33.7		96.5	3.5	74.0	0.1	0.0	25.8	50.0	50.0	0	5.0	17.5	18.0	-0.5
1964 data:																
Small																
9114	0.307	3.2		84.4	15.6	59.5	0.0	0.0	40.5	86.9	13.1	0	3.6	15.4	16.7	-1.3
64114	0.240	2.5		92.4	7.6	100.0	0.0	0.0	0.0	86.9	13.1	0	4.2	17.6	17.6	0.0
Medium																
16214	1.140	11.7		96.7	3.3	88.9	0.4	0.0	10.7	7.5	92.5	0	3.9	17.0	17.5	-0.5
68214	0.985	10.1		92.0	8.0	50.4	31.7	9.6	8.3	7.5	92.5	100	3.3	18.5	17.2	1.3
74214	1.899	19.6		91.7	8.3	74.9	17.5	7.5	0.0	7.5	92.5	100	3.6	18.2	17.2	1.0
Large																
222314	3.276	33.7		96.5	3.5	74.7	0.1	0.0	25.1	7.0	93.0	0	5.0	16.3	18.1	-1.8
Differences:																
Small																
9114	0.023	0.0		1.0	-1.0	2.5	0.0	0.0	-2.5	0.0	0.0	0	0.1	-1.1	0.1	-1.2
64114	0.018	0.0		0.4	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	-1.4	0.0	-1.4
Medium																
16214	0.086	0.0		-0.6	0.6	-0.1	-0.1	0.0	0.2	0.0	0.0	0	0.0	-1.4	0.0	-1.4
68214	0.075	0.0		-0.2	0.2	3.1	-2.8	-0.5	0.3	-62.3	62.3	100	0.1	-1.6	-0.4	-1.2
74214	0.144	0.0		-0.2	0.2	1.6	-1.3	-0.2	0.0	0.0	0.0	0	0.0	-1.6	0.0	-1.6
Large																
222314	0.252	0.0		0.0	0.0	0.7	0.0	0.0	-0.7	-43.0	43.0	0	0.0	-1.2	0.1	-1.3

Table 13--Regression analysis of simulated output to actual output for a selected market by subsystem for 1964 and differences between 1960 and 1964

Subsystem	N	1964				Differences			
		Coefficients 1/		R^2	F 2/	Coefficients 1/		R^2	F 2/
		a	b			a	b		
Output	6	0.07	0.94 (0.07)	0.98	0.387	0.070	-0.120 (0.950)	0.004	0.770
Market share	6	0.70	0.95 (0.07)	0.98	0.330	(3/)			
Labeling	12	-12.10	0.75 (0.23)	0.52	0.671	(3/)			
Distribution	24	-0.47	1.02 (0.10)	0.83	0.020	-0.003	0.390 (0.230)	0.001	0.037
Ingredient handling	12	12.10	0.76 (0.22)	0.54	0.638	0.000	1.020 (0.420)	0.372	0.001
Production	12	16.67	0.67 (0.24)	0.44	1.000	(3/)			
Sales promotion	6	4.82	-0.21 (0.90)	0.01	0.937	0.550	4.000 (10.580)	0.034	0.059
Revenues	6	26.13	-0.34 (0.42)	0.14	2.165	-2.769	-2.616 (3.371)	0.130	0.670
Costs	6	36.23	-1.00 (1.39)	0.12	1.025	0.425	3.750 (3.881)	0.189	0.334
Profit	6	1.54	0.05 (0.19)	0.01	2.602	1.900	1.000 (1.000)	0.200	0.000

1/ Standard errors of the estimates are in parentheses.

2/ F-statistics are obtained by testing against a null hypothesis where a=0 and b=1.

3/ Estimates cannot be found because the simulated or actual values are all equal to zero.

The model's output on the variables in four of the firms' decision subsystems--labeling, distribution, ingredient handling, and production--shows reasonable correspondence with the actual data for the selected market. The explanations of total variance are all greater than 40 percent. None of the null hypotheses can be rejected at the 5 percent level of confidence.

The model's output on per unit sales promotion shows some correspondence to that of the real system as indicated in tables 11 and 12. The F-test indicates that the null hypothesis cannot be rejected at the 5 percent level of confidence.

An examination of per unit revenues and per unit total costs indicates that the model generally predicts below that of the market. The gap between the model's average costs and average revenue and the real market's average cost and average revenue may be an indication of the difference between the market's cost level and that of the average in the United States which served as the basis for the model formulation. The F-test does not reject the null hypothesis for revenues, costs, or profits, but this result is primarily because of the low correlation between the simulated and actual data.

As a whole, the model does reasonably well in predicting the levels of the variables in the real system. Of the 10 tests used to validate the model, none rejected the model as representative of a market which registered sizable changes. The explanation of total variance in each regression equation would likely improve if all markets were included in the analysis. But using a market which has a large amount of change in the analysis strengthens the testing procedure.

First Differences of Variables

It is also interesting to determine if the model can accurately predict change in firms' operations, that is, the difference in levels of output variables between 1960 and 1964. Such results require a more sensitive model than does prediction of the variable's levels.

An analysis of F-tests, using comparisons of first differences similar to those used in validating the levels of the variables, shows that the model cannot be rejected (table 13). None of the 10 F-tests comes close to rejecting the null hypothesis at the 5 percent level of confidence.

The model shows little change from 1960 to 1964. In fact, the only variables that show much change are quantity sold, percentage of flour handled in bags or bulk, and method of ingredient handling. The changes in other variables are linked closely to the increasing demand for bread over time and the adoption patterns for bulk handling and continuous mix.

The explanation of total variance for each regression is poor; in fact, the explanations are almost nonexistent. So even though the null hypotheses cannot be rejected in a statistical sense, they cannot be accepted either because of too many other potential null hypotheses which could not be rejected. But the general movement for many of the decision variables in the model's output are in the same direction as those for the actual market, as indicated by comparing the signs of the differences in tables 11 and 12. Consequently, the model does a reasonable job of predicting levels in variables, but it is not sensitive enough to predict changes in levels.

COMPUTER SIMULATION EXPERIMENTS

Four experiments were designed for the simulation model. First, driver-salesperson home service is deleted as a distribution outlet.[47/] Second, pricing policy is changed to reflect more nearly the differences in costs of servicing outlets. Third, the 7 percent commission on sales paid to salespersons is omitted from drop-stop and dock-pickup outlets. And fourth, pricing policy is

47/ This experiment is not discussed in detail in this report, but it was reported (26).

changed in conjunction with lowering distribution costs for drop stop and dock pickup.

A benchmark simulation run was made of the existing economic environment for 1960 and 1964 in table 14. The simulation generates output by using random components for 52 small, 106 medium, and 44 large wholesale firms in 1960 and for 39 small, 112 medium, and 51 large firms in 1964. These firms are from 27 selected market areas across the United States and are shown in table 15. Each market is run separately and the results (means and standard errors) provide the basis for analyzing changes in performance of the baking industry resulting from experimental changes in technology and market rules.

The actual output variables are reported also for 1960 and 1964 in table 14. By comparing these data with the results in the middle part of the table, how well the simulated output fits with that of the entire United States can be judged.

Total quantity available for sale (Q'') by size of firm generally overpredicts the actual values by about 10 percent. In contrast, market shares are almost identical between the model and the real world.

The random components of ex ante and ex post market demand caused overproduction beyond that already encompassed in the actual data. The small firms experienced the greatest excess supply at about 2 percent of their production.

The model shows little difference in Q_{ob} between years. But it generally underpredicts the actual data by approximately 5 percent in 1960 and by 2 percent in 1964.

In the distribution subsystem, the model underpredicts Q_{dsws}, and generally overpredicts quantities for the other distribution outlets. Q_{dsws} is misforecast by 10 percent in 1960 and by about 7 percent in 1964. Since Q_{dshs} is overestimated by only about 1 percent, the remaining overestimation occurs in Q_{drop} and Q_{dock}.

Table 14--Actual output and simulated output of wholesale bakers for 1960 and 1964, and differences[1/]

Comparisons by firm type	Q"	MS	OP	Q_{ob}	Q_{pl}	Q_{dsws}	Q_{dshs}	Q_{drop}	Q_{dock}	Q_{bags}	Q_{bulk}	CNTS* Q_{manu}	SP	REV	COSTS	PROFIT
	Million pounds	--------Percent--------											-------Cents per pound-----			
Actual output in[2/]--																
1960:																
Small	9.137	6.3	0.0	94.3	5.7	89.2	1.4	1.5	7.8	66.2	33.8	4.0	3.7	17.7	17.3	0.4
	(7.194)	(4.6)		(15.2)	(15.2)	(25.7)	(6.2)	(3.8)	(23.8)	(47.1)	(47.1)	(19.0)	(0.9)	(1.7)	(1.9)	(1.4)
Medium	15.097	10.3	0.0	98.3	1.7	92.9	1.1	2.5	3.6	31.8	68.2	14.0	4.0	17.8	17.2	0.6
	(7.205)	(5.3)		(5.9)	(5.9)	(16.5)	(6.2)	(5.6)	(14.8)	(45.7)	(45.7)	(35.0)	(1.6)	(2.3)	(2.4)	(1.4)
Large	32.254	17.4	0.0	98.6	1.4	90.5	3.2	4.7	1.6	28.4	71.6	11.0	4.3	18.9	18.3	0.6
	(16.634)	(8.2)		(4.4)	(4.4)	(20.3)	(12.4)	(15.6)	(8.1)	(43.3)	(43.3)	(32.0)	(1.6)	(2.6)	(3.0)	(1.4)
1964:																
Small	8.439	5.3	0.0	90.6	9.4	87.3	0.7	4.9	7.0	58.9	41.1	10.0	3.9	19.0	18.1	0.9
	(4.574)	(3.1)		(17.7)	(17.7)	(23.4)	(4.4)	(8.6)	(20.3)	(47.9)	(47.9)	(31.0)	(1.5)	(2.6)	(3.0)	(1.4)
Medium	16.063	9.7	0.0	92.7	7.3	89.8	1.3	3.8	5.1	16.0	84.0	37.0	4.4	18.9	18.0	0.9
	(7.799)	(5.3)		(11.8)	(11.8)	(19.3)	(6.4)	(9.2)	(16.3)	(34.6)	(34.6)	(48.0)	(2.3)	(2.8)	(3.5)	(1.8)
Large	34.815	17.4	0.0	95.1	4.9	88.0	2.4	6.1	3.5	9.3	90.7	33.0	4.4	19.2	18.2	1.0
	(18.740)	(8.5)		(7.6)	(7.6)	(21.6)	(10.3)	(16.3)	(13.5)	(25.2)	(25.2)	(48.0)	(1.8)	(2.8)	(3.3)	(1.5)
Simulated output in--																
1960:																
Small	9.615	5.9	1.9	89.1	10.9	78.3	2.8	7.3	11.6	69.2	30.8	3.8	4.2	19.2	17.8	1.4
	(4.560)	(3.6)	(7.5)	(17.1)	(17.1)	(20.3)	(5.5)	(11.6)	(16.7)	(34.5)	(34.5)	(19.4)	(1.5)	(3.0)	(3.6)	(4.7)
Medium	16.965	10.2	0.4	89.8	10.2	83.7	2.0	6.1	8.2	37.9	62.1	14.2	4.2	19.8	17.8	2.0
	(6.965)	(5.0)	(2.4)	(12.5)	(12.5)	(14.9)	(5.8)	(7.1)	(12.0)	(36.0)	(36.0)	(35.0)	(1.6)	(2.7)	(2.8)	(3.7)
Large	35.682	17.7	0.1	93.2	6.8	80.4	4.4	4.7	10.5	30.0	70.0	11.4	5.1	20.2	18.0	2.3
	(18.614)	(8.4)	(0.9)	(7.8)	(7.8)	(17.6)	(9.5)	(6.5)	(14.9)	(30.6)	(30.6)	(32.1)	(2.0)	(2.4)	(3.2)	(4.2)
1964:																
Small	9.108	5.1	0.0	88.8	11.2	83.2	3.8	6.9	6.1	53.6	46.4	10.3	4.3	21.5	18.0	3.5
	(4.076)	(2.9)		(14.9)	(14.9)	(15.2)	(6.6)	(7.4)	(8.3)	(37.3)	(37.3)	(30.7)	(1.7)	(3.3)	(2.2)	(4.2)
Medium	17.695	9.6	0.0	89.9	10.1	82.7	2.2	5.2	9.9	26.0	74.0	36.6	3.9	22.2	18.4	3.8
	(6.977)	(4.9)		(10.9)	(10.9)	(16.2)	(4.4)	(5.9)	(14.5)	(30.4)	(30.4)	(48.4)	(1.4)	(4.6)	(2.8)	(5.2)
Large	38.602	17.4	0.3	94.7	5.3	79.3	3.5	6.9	10.2	28.8	71.2	33.3	4.7	21.2	18.9	2.3
	(19.110)	(8.3)	(1.6)	(5.9)	(5.9)	(18.3)	(9.5)	(7.5)	(14.0)	(27.9)	(27.9)	(47.6)	(1.7)	(4.1)	(2.8)	(5.0)
Differences in--																
1960:																
Small	-0.500	0.4	1.9	5.0	-5.0	11.0	-1.0	-6.0	-4.0	-3.0	3.0	0.0	-0.5	-1.5	-0.5	-1.0
Medium	1.900	0.1	-0.4	8.0	-8.0	10.0	-1.0	-4.0	-5.0	-6.0	6.0	0.0	-0.2	-2.0	-0.6	-1.4
Large	3.500	-0.3	-0.1	5.0	-5.0	10.0	-1.0	0.0	-9.0	-2.0	2.0	0.0	-0.8	-1.3	0.3	-1.7
1964:																
Small	0.700	0.2	0.0	2.0	-2.0	4.0	-3.0	-2.0	1.0	5.0	-5.0	0.0	-0.4	-2.5	0.1	-2.6
Medium	1.600	0.1	0.0	3.0	-3.0	7.0	-1.0	-1.0	-5.0	-10.0	10.0	0.0	0.5	-3.3	-0.4	-2.9
Large	3.800	0.0	-0.3	0.0	0.0	9.0	-1.0	-1.0	-7.0	-20.0	20.0	0.0	-0.3	-2.0	-0.7	-1.3

1/ The means are not weighted. The standard errors are in parentheses.

2/ The source for the actual output is (27).

Table 15--Number of baking firms by type for selected market areas in 1960 and 1964

Market area	Type of wholesale bakeries in 1960: 1/				Type of wholesale bakeries in 1964: 1/			
	Small	Medium	Large	Supermarket	Small	Medium	Large	Supermarket
Delmarva	4	7	1	2	4	6	2	2
Massachusetts	4	2	1	1	3	3	1	1
New Jersey	1	2	1	1	0	2	2	1
New York City	0	4	3	1	0	4	3	1
Upper New York state	7	2	2	1	5	4	2	1
Eastern Pennsylvania	2	2	2	1	2	2	2	1
Western Pennsylvania	2	3	1	1	2	3	1	1
Lower Michigan	0	5	1	1	0	5	1	1
Downstate Illinois	0	8	2	2	0	8	2	2
Chicago	1	3	1	1	1	2	2	1
Indiana	2	7	1	1	2	7	1	2
Northern Ohio	2	3	2	1	1	4	2	1
Southern Ohio	3	7	0	1	3	7	0	1
Kentucky	1	5	1	1	1	5	1	1
Tennesse	2	5	3	1	2	3	5	2
North Carolina	2	7	2	2	1	8	2	2
South Carolina	0	4	0	1	0	4	0	1
Georgia	1	3	1	1	1	2	2	1
Alabama	2	3	0	1	1	4	0	1
Louisiana and Mississippi	2	1	3	1	1	2	3	1
Missouri	1	7	1	1	0	8	1	1
Wichita, Kansas	2	2	1	1	2	2	1	1
Oklahoma and Arkansas	1	4	1	1	1	4	1	1
Southeastern Texas	4	3	2	1	3	3	3	1
Northern California	3	2	4	2	2	3	4	2
Southern California	1	3	6	3	0	4	6	4
Iowa	2	2	1	1	1	3	1	1

1/ Small wholesalers produce less than 250 thousand pounds per week; medium wholesalers, 250-500 thousand pounds per week; large wholesalers more than 500 thousand pounds per week.

The rather substantial underestimation of Q_{bulk} for medium and large firms in 1964 was 10 and 20 percent, respectively. The other values of Q_{bulk} are within about 5 percent of the actual values.

Virtually no difference is shown between outcomes of the model and those of the real world for the percentage of output produced in continuous mix or per unit allocation of funds to sales promotion. Revenues are overpredicted by about 2 cents per pound in each year. The model's per unit costs correspond well with those in the real world; consequently, per unit profits are also overestimated by about 2 cents per pound.

Cost of Services Pricing

As stated previously, bakers were considering changing their pricing policies so that prices associated with each type of outlet more nearly account for costs of servicing that outlet. Although bakers are doing considerable research in developing estimates of the cost of servicing differences, their estimates were not available in time to run this experiment. But rough estimates were made from the analysis of alternative pricing policies. Consequently, this change in economic environment can be explored within the simulation model.

This experiment requires reprogramming of the pricing subroutine to correspond with subsystem 1.0". The subroutine is similar to that for subsystem 1.0, except that prices of other types of outlets are based on cost of servicing differences rather than on a proportionate basis. These prices were based on differences in costs of distribution and labeling. The simulation is run by replacing the original subroutine with the one describing this alternative pricing policy.

The profitability variables for each firm must be altered because this pricing policy derives a different set of prices for dshs, drop, and dock. This

different set of prices causes decreased profit for dshs but increased profit for drop and dock.

The parameters and initializing variables are entered into the simulation program. The results are generated on the variables for each firm in each market area. A summary of the means and standard errors is in table 16.

This table shows that Q", MS, OP; Q_{bag}, Q_{bulk}, and CNTS*Q_{manu} are unchanged relative to the base model of table 11. Since neither the relative profits of distribution outlets nor the pricing framework affects these variables, no changes were expected.

The quantities wrapped by type of label are not much affected. This result may be surprising, unless it is noted that bakers are relatively unresponsive to changed profits in this subsystem. For example, drop's relative profits would have to be in the magnitude of 2.0 in order to raise the mean medium firms' Q_{pl} to 20 percent of Q_{manu}, other things constant. Such an economic environment is not likely.

The distribution subsystem exhibits a shift from Q_{dsws} to Q_{dock} of about 2 percent because of the changed relative profits and the greater responsiveness of bakers in this subsystem.

The slight shift to dock does not affect per unit sales promotion. It involves an average decrease of only 0.8 cents per pound for 2 percent of Q" which when spread over the entire Q" becomes negligible.

Since revenues increased and costs remained constant, profits rose. Revenues increased by 0.6 cents per pound mainly because of the increased P_{drop} and P_{dock}. There was also a slight effect because of the shift towards more profitable outlets. This pricing policy could increase average revenues by 3 percent. Since the slight shift in distribution outlets was not sufficient to affect per unit costs, profits increased by 0.6 cents per pound, or about 13

Table 16--Pricing decisions, including actual costs of servicing distribution outlets, when output of wholesale bakers is simulated for 1960 and 1964 1/

Comparisons by firm size in--	Q"	MS	OP	Q_{ob}	Q_{pl}	Q_{dsws}	Q_{dshs}	Q_{drop}	Q_{dock}	Q_{bags}	Q_{bulk}	CNTS* Q_{manu}	SP	REV	COSTS	PROFIT
	Million pounds	Percent											Cents per pound			
1960:																
Small	9.615 (4.560)	5.9 (3.6)	1.8 (7.4)	89.0 (16.8)	11.0 (16.8)	76.8 (21.5)	2.6 (5.1)	7.3 (10.2)	13.3 (18.5)	69.2 (34.5)	30.8 (34.5)	3.8 (19.4)	4.1 (1.5)	19.8 (2.7)	17.7 (3.6)	2.1 (4.3)
Medium	16.965 (6.695)	10.2 (5.0)	0.4 (2.4)	89.5 (12.7)	10.5 (12.7)	81.8 (16.3)	2.0 (5.6)	6.3 (7.2)	9.9 (13.4)	37.9 (36.0)	62.1 (36.0)	14.2 (35.0)	4.2 (1.6)	20.3 (2.6)	17.7 (2.8)	2.5 (3.7)
Large	35.682 (18.614)	17.7 (8.4)	0.2 (1.2)	92.9 (8.0)	7.1 (8.0)	79.4 (17.7)	4.2 (8.6)	5.0 (6.8)	11:4 (15.6)	30.0 (30.6)	70.0 (30.6)	11.4 (32.1)	5.0 (2.1)	20.7 (2.4)	17.9 (3.2)	2.8 (4.1)
1964:																
Small	9.108 (4.076)	5.1 (2.9)	0.0 (0.0)	88.6 (14.5)	11.4 (14.5)	80.8 (16.6)	3.6 (6.2)	7.4 (8.5)	8.2 (10.3)	53.6 (37.3)	46.4 (37.3)	10.3 (30.7)	4.2 (1.7)	21.9 (3.3)	17.2 (2.2)	4.7 (4.3)
Medium	17.695 (6.977)	9.6 (4.9)	0.0 (0.0)	89.6 (10.9)	10.4 (10.9)	81.1 (17.1)	2.2 (4.2)	5.4 (6.1)	11.4 (15.5)	26.0 (30.4)	74.0 (30.4)	36.6 (48.4)	3.8 (1.4)	22.8 (4.6)	17.7 (2.8)	5.1 (5.4)
Large	38.602 (19.110)	17.4 (8.3)	0.3 (1.6)	94.4 (6.1)	5.6 (6.1)	78.1 (18.6)	3.3 (8.6)	7.4 (7.8)	11.2 (14.7)	28.8 (27.9)	71.2 (27.9)	33.3 (47.6)	4.7 (1.8)	21.8 (4.2)	18.1 (2.8)	3.7 (5.1)

1/ The means are not weighted. The standard errors are in parentheses.

percent. Table 16 shows that this experimental environment, in relation to those considered, has the greatest individual effect on profits.

Although the model has price responsiveness to the general price level of bread, it assumes that consumers will not change their buying habits because of changes in prices among labels or outlets except when the change outlets affect the general price level. Consumers who had home delivery would benefit from the alternative pricing system, since their bread price would have dropped more than 2 cents per pound. Consumers, who purchased at the store, may or may not benefit. There would be no price change on the wholesale branded labels. But the drop-stop delivered or dock-pickup bread may be priced higher than before the changed pricing policy to offset the stores' higher acquisition price.

Incomes of driver-salespersons would not be affected by the changed distribution pattern. Their union contract guarantees commissions on dock-pickup distributed bread.

Deleting Commissions on Drop Stop and Dock Pickup

Drop-stop and dock-pickup delivered bread usually involves a 7 percent commission rate to salespersons in the territory, even if they do not handle the bread (27, p. 109). Thus bakers claim that there are no economic incentives for them to use these outlets. The economic impacts of deleting a 7 percent commission rate on those outlets can be explored in the simulation model.

This experiment again requires the alteration of the profit variables in each firm. Costs of distributing bread in drop-stop or dock-pickup outlets are decreased by 7 percent of their total revenue.

This experiment also requires the alteration of the administrative and distributive cost parameters. These parameters were likewise decreased by 7 percent of the average price for those outlets (table 17). Consequently, the simulation

Table 17--Cost parameters of baking firms when commissions of salespersons are deleted from drop-stop and dock-pickup distribution outlets[1/]

Firm size	Q_{dsws}	Q_{dshs}	Q_{drop}	Q_{dock}	Q_{stor}	Q_{ob}	Q_{pl}	Q_{bulk}	Q_{bags}	CNTL* Q_{manu}	CNTS* Q_{manu}	$\hat{S}_y$
Small wholesale	7.48	13.18	5.87	4.31		1.29	1.58	7.96	8.63	3.64	2.86	16.8
Medium wholesale	7.68	10.73	5.39	6.87		1.27	1.32	8.02	8.27	3.45	3.14	34.5
Large wholesale	8.54	12.76	6.37	7.26		1.24	0.81	8.63	8.46	3.31	2.91	75.8
Chain store			5.39		6.87		1.32	8.02	8.27	3.45	3.14	

1/ All parameters are shown in table 6 except those of Q_{drop}, Q_{dock}, and Q_{stor}. The parameters for those outlets were decreased by 7 percent of the outlets' per unit revenues (15.36 for drop and 13.44 for dock), that is, the parameters were decreased by 1.08 and 0.94, respectively. The parameters for chain stores are based on those for medium wholesalers.

should indicate the effects of behavioral shifts in distribution habits and changes in relative costs on profits of wholesale bakers.

These parameters and initializing variables are entered into the simulation program. The results are generated on the variables for each firm in each market area. A summary of the means and standard errors is reported in table 18.

There is no change in Q", MS, OP, Q_{bag}, Q_{bulk} or CNTS*Q_{manu} because the relative profits do not affect these variables.

The outcomes of the labeling subsystem are changed slightly. There is an increase of about 0.1 percent in Q_{pl}, because the relative profit of drop and dock increased, and two relative profit of dsws and dshs decreased. The overall effect on this subsystem is minimal because of the bakers' unresponsiveness as previously discussed.

The distribution subsystem shifts about 0.5 percent of Q" from dsws to drop and dock. Q_{drop} and Q_{dock} share about equally in the shift, that is, about 0.2 to 0.3 percent increased distribution. This shifting pattern is because of the changed relative profits as well as the slight increase in Q_{pl}. No change is registered in per unit sales promotion because of these small shifts in labeling and distribution.

Per unit revenues are also not affected. But costs are reduced 0.1 to 0.2 cent per pound, entirely because the costs of distributing drop and dock decreased. Hence, profits increased by 0.1 to 0.2 cent per pound. This increase in profits may sound small; but, in terms of the national production for 1963, it means about $10 to $20 million to the industry.

The behavioral parameters used in this situation were identical to those used in the base model. It is possible that firms would shift their attitudes towards labeling practices and distribution outlets if faced with a substantial reduction in commissions on drop stop and dock pickup. A method of obtaining an

Table 18--Results of deleting 7 percent commissions on drop stop and dock pickup when output of wholesale bakers is simulated for 1960 and 1964[1/]

Comparisons by firm size in--	Q"	MS	OP	Q_{ob}	Q_{pl}	Q_{dsws}	Q_{dshs}	Q_{drop}	Q_{dock}	Q_{bags}	Q_{bulk}	CNTS* Q_{manu}	SP	REV	COSTS	PROFIT
	Million pounds	Percent											Cents per pound			
1960:																
Small	9.615	5.9	1.9	89.0	11.0	77.9	2.8	7.5	11.8	69.2	30.8	3.8	4.2	19.2	17.6	1.6
	(4.560)	(3.6)	(7.5)	(17.1)	(17.1)	(20.5)	(5.5)	(11.6)	(16.9)	(34.5)	(34.5)	(19.4)	(1.5)	(3.0)	(3.5)	(4.5)
Medium	16.965	10.2	0.4	89.6	10.4	83.2	2.0	6.3	8.5	37.9	62.1	14.2	4.2	19.8	17.6	2.2
	(6.695)	(5.0)	(2.4)	(12.6)	(12.6)	(15.2)	(5.8)	(7.2)	(12.2)	(36.0)	(36.0)	(35.0)	(1.6)	(2.7)	(2.8)	(3.7)
Large	35.682	17.7	0.1	93.1	6.9	79.9	4.4	5.0	10.7	30.0	70.0	11.4	5.1	20.2	17.8	2.4
	(18.614)	(8.4)	(0.9)	(7.8)	(7.8)	(17.8)	(9.5)	(6.8)	(15.0)	(30.6)	(30.6)	(32.1)	(2.0)	(2.4)	(3.1)	(4.1)
1964:																
Small	9.108	5.1	0.0	88.7	11.3	82.6	3.8	7.2	6.5	53.6	46.4	10.3	4.3	21.5	17.2	4.4
	(4.076)	(2.9)	(0.0)	(14.9)	(14.9)	(15.5)	(6.6)	(7.6)	(8.6)	(37.3)	(37.3)	(30.7)	(1.7)	(3.3)	(2.2)	(4.2)
Medium	17.695	9.6	0.0	89.7	10.3	82.3	2.2	5.4	10.2	26.0	74.0	36.6	3.9	22.2	17.6	4.6
	(6.977)	(4.9)	(.0.0)	(11.0)	(11.0)	(16.4)	(4.4)	(6.0)	(14.7)	(30.4)	(30.4)	(48.4)	(1.4)	(4.6)	(2.8)	(5.2)
Large	38.602	17.4	0.3	94.6	5.4	78.7	3.5	7.3	10.4	28.8	71.2	33.3	4.7	21.1	18.0	3.2
	(19.110)	(8.3)	(1.6)	(6.0)	(6.0)	(18.7)	(9.5)	(7.8)	(14.3)	(27.9)	(27.9)	(47.6)	(1.7)	(4.1)	(2.8)	(5.0)

1/ The means are not weighted. The standard errors are in parentheses.

estimate of such a change could be with a Delphi type of questionnaire. Firms would be given the percentages of production wrapped by type of label (parameters on Q_{manu} in table 3) and distributed by type of outlet (parameters on Q" in table 5) as well as the assumptions of the alternative situation. Then they would be asked to indicate how they would change the percentages. These data would be summarized and substituted in the decision framework. But this procedure was beyond the objectives of the study.

In the model, consumers are indifferent to the changed commission structure because the prices they face are identical before and after the change. Sales personnel, however, would be affected by this change. Their income would decrease substantially, so they have a large economic incentive to maintain the current economic environment. The model's outcome is based on an assumption of passive acceptance of commission deletion by sales personnel which shows the extreme benefits possible to bakers. After bargaining between sales personnel and bakery management, the end result would more likely be somewhere between the actual situation and the simulated extreme.

Combining the Two Experiments

This experiment is a combination of the previous two independent experiments. Its purpose is to investigate the effects on costs and revenues from a twofold change in economic environment.

The model's input reflects the combined influences of a changed pricing policy and of changed sales commission framework. The cost parameters are altered to correspond to the decreased commissions. The profit variables for each firm are altered to indicate the changed revenue and cost situations. A summary of the means and standard errors is reported in table 19.

Table 19--Pricing decisions, including actual costs of servicing distribution outlets and deleting 7 percent commissions on drop stop and dock pickup, when output of wholesale bakers is simulated for 1960 and 1964 1/

Comparisons by firm size in--	Q"	MS	OP	Q_{ob}	Q_{pl}	Q_{dsws}	Q_{dshs}	Q_{drop}	Q_{dock}	Q_{bags}	Q_{bulk}	CNTS* Q_{manu}	SP	REV	COSTS	PROFIT
	Million pounds	Percent											Cents per pound			
1960:																
Small	9.615 (4.560)	5.9 (3.6)	1.8 (7.4)	88.9 (16.8)	11.1 (16.8)	76.4 (21.8)	2.6 (5.0)	7.5 (10.3)	13.5 (18.7)	69.2 (34.5)	30.8 (34.5)	3.8 (19.4)	4.1 (1.5)	19.8 (2.7)	17.5 (3.5)	2.3 (4.2)
Medium	16.965 (6.695)	10.2 (5.0)	0.4 (2.4)	89.3 (12.8)	10.7 (12.8)	81.3 (16.7)	2.0 (5.6)	6.4 (7.3)	10.3 (13.8)	37.9 (36.0)	62.1 (36.0)	14.2 (35.0)	4.2 (1.6)	20.2 (2.6)	17.6 (2.8)	2.7 (3.7)
Large	35.682 (18.614)	17.7 (8.4)	0.2 (1.2)	92.8 (8.1)	7.2 (8.1)	78.9 (17.9)	4.2 (8.6)	5.3 (7.1)	11.6 (15.7)	30.0 (30.6)	70.0 (30.6)	11.4 (32.1)	5.0 (2.1)	20.7 (2.4)	17.7 (3.2)	3.0 (4.1)
1964:																
Small	9.108 (4.076)	5.1 (2.9)	0.0 (0.0)	88.5 (14.5)	11.5 (14.5)	80.1 (16.9)	3.7 (6.2)	7.7 (8.9)	8.6 (10.7)	53.6 (37.3)	46.4 (37.3)	10.3 (30.7)	4.2 (1.7)	21.8 (3.3)	17.0 (2.2)	4.8 (4.2)
Medium	17.695 (6.977)	9.6 (4.9)	0.0 (0.0)	89.5 (10.9)	10.5 (10.9)	80.4 (17.6)	2.2 (4.1)	5.6 (6.2)	11.8 (15.9)	26.0 (30.4)	74.0 (30.4)	36.6 (48.4)	3.8 (1.4)	22.8 (4.6)	17.5 (2.8)	5.2 (5.4)
Large	38.602 (19.110)	17.4 (8.3)	0.3 (1.6)	94.3 (6.2)	5.7 (6.2)	77.4 (19.0)	3.3 (8.6)	7.9 (8.1)	11.4 (15.0)	28.8 (27.9)	71.2 (27.9)	33.3 (47.6)	4.7 (1.8)	21.7 (4.2)	17.9 (2.8)	3.8 (5.1)

1/ The means are not weighted. The standard errors are in parentheses.

This experiment again registered no change on Q", MS, OP Q_{bag}, Q_{bulk}, and CNTS*Q_{manu} because neither the relative profit nor the pricing policy has any effect on these variables.

The labeling subsystem shows some shifting from ob to pl, about 0.2 to 0.4 percent. This shift is because of the changed relative profits, and it reflects greater movement than the sum of the independent experiments on this alternative pricing policy and decreased sales commissions on drop and dock.

The distribution subsystem reflects shifts in all outlets. Allocation to dsws decreases by about 2 percent and to dshs by about 0.2 percent. But drop increases by 0.2 to 1.0 percent, and dock increases by 1.0 to 2.0 percent. These shifts reflect the changed relative profits of the combined situation with cost of service pricing and decreased sales commissions on drop and dock and in part with the increased Q_{pl}.

Revenues increased by 0.5 cents per pound. At the same time, costs decreased by 0.2 cents. This twofold change in economic environment improves profits by 0.7 cents per pound.[48/] There is a large percentage increase in profits, about 15 percent. In terms of wholesale baking industry total profits for 1963, the increase would be about $80 million. The combination of cost of service pricing and deletion of commissions on drop stop and dock pickup has about the same effect on profits as the summation of the two environments considered (table 20).

As in the case considering only costs of service in pricing, consumers using home delivery would benefit from this twofold change in economic environment. The effect on consumers who purchase at the store is not apparent. There would

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48/ In the longrun, revenues and profits may decrease slightly because the price differences were developed from information in the benchmark situation rather than from costs associated with the omitted commissions.

Table 20--Revenues, costs, and profits per pound for the base model and experimental economic environments by size of wholesale firm for 1964 1/

Type of environment	Small firm			Medium firm			Large firm		
	REV	COSTS	PROFIT	REV	COSTS	PROFIT	REV	COSTS	PROFIT
	Cents								
Base model	21.5 (3.3)	17.2 (2.2)	4.3 (4.2)	22.2 (4.6)	17.7 (2.8)	4.5 (5.2)	21.2 (4.1)	18.1 (2.8)	3.1 (5.1)
Cost of services pricing	21.9 (3.3)	17.2 (2.2)	4.7 (4.3)	22.8 (4.6)	17.7 (2.8)	5.1 (5.4)	21.8 (4.2)	18.1 (2.8)	3.7 (5.1)
Deleting 7 percent commission on drop stop and dock pickup	21.5 (3.3)	17.1 (2.2)	4.4 (4.2)	22.2 (4.6)	17.5 (2.8)	4.6 (5.2)	21.1 (4.1)	17.9 (2.8)	3.2 (5.0)
Cost of services pricing and deleting 7 percent commissions on drop stop and dock pickup	21.8 (3.3)	17.0 (2.2)	4.8 (4.2)	22.8 (4.6)	17.5 (2.8)	5.2 (5.4)	21.7 (4.2)	17.9 (2.8)	3.8 (5.1)

1/ Standard errors are in parentheses.

be no change in P_{dsws}, but stores may price drop-delivered and dock-pickup bread higher than before in order to offset the store's higher acquisition cost.

Driver-salesperson income would be decreased by the eliminated commissions on drop and dock and by the increased percentage distributed in those outlets. Hence, the unions would probably push for a change in price policy but resist a change in the commission structure.

FUTURE RESEARCH

The results of using the systems model to measure efficiencies of alternative distribution systems and pricing policies indicate some areas of future research on the baking industry. Four such areas are (1) pricing policies, (2) cost functions, (3) elasticities of demand for bread in alternative types of outlets, and (4) restraints on labeling and distribution behavior.

The model is sensitive to the pricing formulation. Consequently, pricing research may involve determining the price proportions on a regional basis or setting up distinct regional pricing policies.

Cost functions need additional research. Primary emphasis should be put on the form of the equation used to estimate administration and distribution and sales promotion. Cost function research may involve exploring spatial or demographic properties of distribution costs as well as regional differences in costs. To make the model useful for the 1970's, the minimum effort would require updating the coefficients.

The model, by the nature of its assumptions, possesses certain built-in rigidities. A case in point is the lack of consumer response to price changes between bread outlets, for example, home delivery and store purchases. Some experiments should be made to determine the importance of consumer demand by type of distribution outlet. Such analysis would focus on the sensitivity of the model to the elasticity of substitution of bread from alternative outlets.

The model could be reformulated so that bakers' decisions on quantities distributed by type of outlet would consider information about these elasticities of substitution in the various outlets. If the model is sensitive, then an experimental pricing study should be undertaken to obtain estimates of these elasticities.

The parameters used in the labeling and distribution framework are associated implicitly with institutional and contractual arrangements. These parameters in the base model may not be appropriate for a changed economic environment. Further research would be desirable on response of bakers to the relaxation of constraints under different situations.

Such research could have a high payoff. The above analyses shows that bakers' net incomes could be increased through changed pricing patterns and distribution behavior. Improving components in the model should improve its usefulness and assist the implementation of such recommendations into workable decisions. The above refinements should assist in that task.

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APPENDIX A

Summary of the Baking Industry Model

The objective of this study was to develop a systems model of the baking subsector that can be used to measure and appraise the effect on bread prices and on firm profit rates after reallocating resources in bread distribution. The reallocation may be intrafirm or intraindustry. But in either case, the model accounts for coordination of interfirm behavior. This appendix summarizes and discusses certain aspects of the final formulation.

The model is formulated mathematically in appendix table 1 as it was programmed for computer analysis. The variables are defined in appendix table 2 in order of appearance. Only variables denoting different time periods are subscripted by time. All other variables are for time t.

Appendix table 1--Mathematical formulation of bakery market simulation model

Initialize:

(Industry)

Parameter values for three firm sizes

(Each firm)

YR, NP, KTYPE, M, QC, CNTS, CNTL, NOBULK, BULK, QS_{t-1}, $\frac{\pi_{dsws}}{\pi_{all}}$,

$\frac{\pi_{dshs}}{\pi_{all}}$, $\frac{\pi_{drop}}{\pi_{all}}$, $\frac{\pi_{dock}}{\pi_{all}}$ σ^2, $Q_{dsws\ t-1}$, AC_{t-1}, MA_{t-1}.

(Each market)

YR, NAME, NSW, NMW, NLW, NWF, NSM, NF, CD_{t-1}, Y_t, Y_{t-1} CPI_t,

CPI_{t-1}, POP_t, POP_{t-1}.

Set Price: (subsystem 1.0)

(Each market--current policy of proportional prices)

(1.1) $P_{dsws} = \text{Max}[AC_{i\ t-1}]\ i=1,2,\ldots,NWF;$

subject to: $PCTQ_{i\ t-1} \geq k;\ o \leq k \leq 100;$

(1.2) $P_{dshs} = a_1 P_{dsws};$

(1.3) $P_{drop} = a_2 P_{dsws};$

(1.4) $P_{dock} = a_3 P_{dsws};$ and

(1.5) $P_{stor} = a_4 P_{dsws}.$

(subsystem 1.0')

(Each market--alternative policy with constant differences)

(1.1') $P_{dsws} = \text{Max}[AC_{i\ t-1}]\ i=1,2,\ldots,NWF;$

subject to: $PCTQ_{i\ t-1} \geq k;\ 0 \leq k \leq 100;$

(1.2') $P_{dshs} = P_{dsws} + \delta_1;$

(1.3') $P_{drop} = P_{dsws} + \delta_2;$

(1.4') $P_{dock} = P_{dsws} + \delta_3;$ and

(1.5') $P_{stor} = P_{dsws} + \delta_4.$

Market Demand: (subsystem 2.0)

(Each firm ex ante and each market ex post)

(2.1) $$\overline{CD}_t = A_{11} + b_{11}P - \rho b_{11}P_{t-1} + b_{12}Y - \rho b_{12}Y_{t-1} + b_{13}\text{Cos}(.523599t - .415) + \rho\overline{CD}_{t-1} + U;$$ and

(2.2) $$CD = \sum_{t=1}^{12} POP * \overline{CD}_t.$$

Determine Quantity Produced: (subsystem 3.0)

(Each firm)

(3.1) $$QP^* = \frac{QS_{t-1}}{CD_{t-1}} * CD_t;$$ and

$$(3.2) \qquad Q_{manu} = \begin{cases} QP^* \text{ if } QP^* \leq 1.5*QC \\ 1.5*QC \text{ otherwise.} \end{cases}$$

$$(3.3) \qquad Q'' = Q_{manu}$$

Labeling Decision: (subsystem 4.0)

(Each firm)

$$(4.1) \qquad Q_{ob} = b_1 Q_{manu} + b_2 \frac{\pi_{dsws}}{\pi_{all}} + b_3 \frac{\pi_{dshs}}{\pi_{all}} + b_4 \frac{\pi_{drop}}{\pi_{all}} + b_5 \frac{\pi_{dock}}{\pi_{all}}$$

$$+ b_6 \sigma^2 + U_{ob}; \text{ where } 0 \leq Q_{ob} \leq Q_{manu}; \text{ and}$$

$$(4.2) \qquad Q_{pl} = Q_{manu} - Q_{ob}.$$

Distribution Decision: (subsystem 5.0)

(Each firm)

$$(5.1) \qquad Q_{dsws} = b_{11} Q'' + b_{12} Q_{pl} + b_{13} \frac{\pi_{dsws}}{\pi_{all}} + b_{14} \frac{\pi_{dshs}}{\pi_{all}} + b_{15} \frac{\pi_{drop}}{\pi_{all}}$$

$$+ b_{16} \frac{\pi_{dock}}{\pi_{all}} + b_{17} \sigma^2 + U_{dsws};$$

$$(5.2) \qquad Q_{dshs} = b_{21} Q'' + b_{22} Q_{pl} + b_{23} \frac{\pi_{dsws}}{\pi_{all}} + b_{24} \frac{\pi_{dshs}}{\pi_{all}} + b_{25} \frac{\pi_{drop}}{\pi_{all}}$$

$$+ b_{26} \frac{\pi_{dock}}{\pi_{all}} + b_{27} \sigma^2 + U_{dshs};$$

$$(5.3) \qquad Q_{drop} = b_{31} Q'' + b_{32} Q_{pl} + b_{33} \frac{\pi_{dsws}}{\pi_{all}} + b_{34} \frac{\pi_{dshs}}{\pi_{all}} + b_{35} \frac{\pi_{drop}}{\pi_{all}}$$

$$+ b_{36} \frac{\pi_{dock}}{\pi_{all}} + b_{37} \sigma^2 + U_{drop};$$

$$(5.4) \qquad Q_{dock} = b_{41} Q'' + b_{42} Q_{pl} + b_{43} \frac{\pi_{dsws}}{\pi_{all}} + b_{44} \frac{\pi_{dshs}}{\pi_{all}} + b_{45} \frac{\pi_{drop}}{\pi_{all}}$$

$$+ b_{46} \frac{\pi_{dock}}{\pi_{all}} + b_{37} \sigma^2 + U_{dock};$$

(5.5) $Q_{stor} = \gamma Q''$; where $0 \leq Q_{dsws}, Q_{dshs}, Q_{drop}, Q_{dock}$, and

$Q_{stor} \leq Q''$ and $Q_{dsws} + Q_{dshs} + Q_{drop} + Q_{dock}$

$+ Q_{stor} = Q''$.

Production Decision: (subsystem 6.0)

(Each firm--decision framework is used only if production mix status is not known)

$$(6.1)\qquad PROP_t^{cnts} = 1.0 / 1.0 + e^{-(a + bt)};$$

$$(6.2)\qquad PROB_{12}^{mix} = \frac{PROP_{t+1}^{cnts} - PROP_t^{cnts}}{1.0 - PROP_t^{cnts}};$$

$$(6.3)\qquad CNTS_t = \begin{cases} 1.0 \text{ if } PROB_{12}^{mix} \geq R_u^{mix} \\ 0.0 \text{ otherwise} \end{cases}; \text{ and}$$

$$(6.4)\qquad CNTL_t = \begin{cases} 1.0 \text{ if } CNTS_t = 0.0 \\ 0.0 \text{ otherwise.} \end{cases}$$

Ingredient Decision: (subsystem 7.0)

(Each firm--decision equations 7.1 to 7.4 are used only if ingredient handling status is not known)

$$(7.1)\qquad PROP_t^{bulk} = 1.0 / 1.0 + e^{-(a + bt)};$$

$$(7.2)\qquad PROP_{12}^{ing} = \frac{PROP_{t+1}^{bulk} - PROP_t^{bulk}}{1.0 - PROP_t^{bulk}};$$

$$(7.3)\qquad BULK_t = \begin{cases} 1.0 \text{ if } PROB_{12}^{ing} \geq R_u^{ing} \\ 0.0 \text{ otherwise;} \end{cases}$$

$$(7.4)\qquad NOBULK = \begin{cases} 1 \text{ if } BULK_t = 0 \\ 0 \text{ otherwise;} \end{cases}$$

(7.5) $Q_{flour} = b_{11}Q_{manu} + U_{flour}$;

(7.6) $Q_{bulk} = (a_{21} + b_{21}BULK + U_{bulk}) * Q_{flour}$;

where $0 \leq Q_{bulk} \leq Q_{flour}$; and

(7.7) $Q_{bag} = Q_{flour} - Q_{bulk}$.

Sales Promotion Behavior: (subsystem 8.0)

(Each firm)

(8.1) $\$_{pack} = b_{11}Q_{ob} + b_{12}Q_{pl} + U_{pack}$;

(8.2) $\$_{deduct} = b_{21}\ (Q_{dsws} + Q_{dshs}) + b_{22}Q_{drop} + b_{23}Q_{dock} + U_{deduct}$; and

(8.3) $\$_{promot} = \$_{pack} + \$_{deduct}$; where $.015 \leq \frac{\$_{promot}}{Q''} \leq .10$.

Market Share: (subsystem 9.0)

(Wholesale firms)

(9.1) $MS^{*} = d_1S + d_2M + d_3L + b_1NSW + b_2NMW + b_3NLW + b_4\ \frac{SP}{SSP} + U$;

(9.2) $MS = \frac{MS^{*}}{\sum_{i=1}^{NWF} MS_i^{*}} * .808$;

(Chain stores)

(9.3) $MS = 0.116/NSM$;

(Each firm)

(9.4) $PD = MS * CD$;

(9.5) $QS = \begin{cases} PD \text{ if } Q'' \geq PD \\ Q'' \text{ otherwise;} \end{cases}$

(9.6) $OP = \begin{cases} Q'' - PD \text{ if } Q'' > PD \\ 0 \text{ otherwise; and} \end{cases}$

$$(9.7)\quad \Delta PD_j = \mathrm{Min}\left[OP_j; \left(\frac{MS_j}{\sum_{k=1}^{NF} MS_k}\right) * |OP_i|\right]; \text{ for } k \neq h \text{ where } OP_h \leq 0.$$

Revenues: (subsystem 10.0)

(Each firm)

$$\$_{rev} = P_{dsws} * Q_{dsws} - \left(\frac{Q_{dsws}}{Q_{dsws} + Q_{dshs}}\right) * OP$$

$$+ P_{dshs} * Q_{dshs} - \left(\frac{Q_{dshs}}{Q_{dsws} + Q_{dshs}}\right) * OP$$

$$+ P_{drop} * Q_{drop} + P_{dock} * Q_{dock} + P_{stor} * Q_{stor}.$$

Cost Functions: (subsystem 11.0)

(Each firm)

$$(11.1)\quad \$_{ingred} = b_{11}Q_{bulk} + b_{12}Q_{bags} + U_{ingred};$$

$$(11.2)\quad \$_{manu} = b_{21}CNTL * Q_{manu} + b_{22}CNTS * Q_{manu} + U_{manu};$$

$$(11.3)\quad \$_{admin} = b_{31}Q_{dsws} + b_{32}Q_{dshs} + b_{33}Q_{drop} + b_{34}Q_{dock} + U_{admin}; \text{ and}$$

$$(11.4)\quad \$_{costs} = \$_{ingred} + \$_{manu} + \$_{admin} + \$_{promot};$$

where $.10 \leq \frac{\$_{costs}}{Q''} \leq .35.$

Profits: (subsystem 12.0)

$$(12.1)\quad ASP = \$_{promot}/Q'';$$

$$(12.2)\quad AC = \$_{costs}/Q'';$$

$$(12.3)\quad AR = \$_{rev}/Q'';$$

$$(12.4)\quad \pi = (\$_{rev} - \$_{costs})/Q''; \text{ and}$$

$$(12.5)\quad \pi_{ind} = \sum_{i=1}^{NWF} (\$_{rev} - \$_{costs}) / \sum_{i=1}^{NWF} Q''.$$

Printout:

(Each firm)

Q'', MS, OP, Q_{ob}, Q_{pl}, Q_{dsws}, Q_{dshs}, Q_{drop}, Q_{dock}, Q_{stor}, Q_{bags}, Q_{bulk},
CNTS, ASP, AR, AC, π.

(Each market)

P_{dsws}, P_{dshs}, P_{drop}, P_{dock}, P_{stor}, CD, π_{ind}.

(Industry)

Means and standard errors of these variables by type of firm.

APPENDIX TABLE A.2

Definitions of Variables in Baking Market Model

Definition of Variables: (In order of appearance)

YR = year simulated

NP = code number of firm

KTYPE = type (size) of firm

M = market number

QC = capacity in thousand pounds per year

CNTS = dummy variable denoting continuous mix

CNTL = dummy variable denoting conventional mix

NOBULK = dummy variable denoting no bulk handling equipment

BULK = dummy variable denoting bulk handling equipment

QS = quantity sold in thousand pounds per year

$\frac{\pi_{dsws}}{\pi_{all}}$ = driver-salesperson wholesale profit relative to the weighted average of all outlets

$\frac{\pi_{dshs}}{\pi_{all}}$ = driver-salesperson home service profit relative to the weighted average of all outlets

$\frac{\pi_{drop}}{\pi_{all}}$ = drop-stop delivery profit relative to the weighted average of all outlets

$\frac{\pi_{dock}}{\pi_{all}}$ = dock-pickup profit relative to the weighted average of all outlets

σ^2 = risk defined as the squared difference between a firm's average per unit revenue and that of the market

Q_{dsws} = quantities distributed by driver-salesperson wholesale in thousand pounds

AC = average cost in cents per pound

MS = market share

NAME = market's name

NSW = number of small wholesale firms in the market

NMW = number of medium wholesale firms in the market

NLW = number of large wholesale firms in the market

NMF = number of wholesale firms

NSM = number of chain stores

NF = total number of firms

CD = consumption of bread and bread type rolls in thousand pounds per year

Y = per capita monthly income in dollars

CPI = consumer price index

POP = population in thousands

P_{dsws} = wholesale price for the driver-salesperson wholesale outlet

$PCTQ_i$ = Q_{dsws} as percent of QS for firm i

P_{dshs} = wholesale price for driver-salesperson home service outlet

P_{drop} = wholesale price for the drop-stop outlet

P_{dock} = wholesale price for the dock-pickup outlet

P_{stor} = wholesale price for the chain store outlet

$\overline{CD}$ = monthly per capita consumption of bread and bread type rolls in pounds

P = retail white pan bread price divided by consumer price index

Y = per capita monthly income divided by consumer price index

$COS(\theta t - \psi)$ = a monthly cycle

U = disturbance for predicting $\overline{CD}$ in pounds per month

QP* = desired quantity of production in thousand pounds per year

Q_{manu} = actual quantity manufactured in thousand pounds per year

Q_{ob} = quantities wrapped as own brand in thousand pounds per year

U_{ob} = disturbance for predicting Q_{ob} in thousand pounds per year

Q_{pl} = quantities wrapped as private label in thousand pounds per year

Q" = total quantity available for sale

U_{dsws} = disturbance for predicting Q_{dsws} in thousand pounds per year

Q_{dshs} = quantities distributed as driver-salesperson home service in thousands pounds per year

U_{dshs} = disturbance for predicting Q_{dshs} in thousand pounds per year

Q_{drop} = quantities distributed as drop stop in thousand pounds per year

U_{drop} = disturbance for predicting Q_{drop} in thousand pounds per year

Q_{dock} = quantities distributed as dock pickup in thousand pounds per year

U_{dock} = disturbance for predicting Q_{dock} in thousand pounds per year

Q_{stor} = quantities of chain store bread baked at the store in thousand pounds per year

$PROP^{cnts}$ = the proportion of firms with continuous mix

$PROB^{mix}$ = the probability that a firm without continuous mix will adopt it in the next period

R_u^{mix} = a uniform random variable $[0 \leq R_u^{mix} \leq 1]$

$PROP^{bulk}$ = the proportion of firms using bulk handling equipment

$PROP_{12}^{ing}$ = the probability that a firm without bulk handling equipment will adopt it in the next period

R_u^{ing} = a random variable $[0 \leq R_u^{ing} \leq 1]$ Q_{flour}

Q_{flour} = the quantity of flour demanded in thousand pounds per year

U_{flour} = disturbance for predicting Q_{flour} in thousand pounds per year

Q_{bulk} = the quantity of flour demanded as bulk mix in thousand pounds per year

U_{bulk} = the disturbance of predicting percentage of flour handled in bulk in thousand pounds per year

$\$_{pack}$ = value of packaging, wrapping materials, cartons, and other shipping containers and supplies in thousand dollars

U_{pack} = disturbance for predicting $\$_{pack}$ in thousand dollars

$\$_{deduc}$ = value of selling deductions, advertising, and promotion in thousand dollars

U_{deduc} = disturbance for predicting $\$_{deduc}$ in thousand dollars

$\$_{promot}$ = total value of sales promotion in thousand dollars

S = dummy variable denoting small wholesale firm

M = dummy variable denoting medium wholesale firm

L = dummy variable denoting large wholesale firm

$\frac{SP}{SSP}$ = a firm's share of total market advertising

U = disturbance for predicting MS

PD = product demand in thousand pounds per year

OP = quantity of overproduction in thousand pounds per year

ΔPD = change in product demand in thousand pounds per year

$\$_{rev}$ = total revenue in thousand dollars

$\$_{ingred}$ = costs of ingredients in thousand dollars

U_{ingred} = disturbance for predicting $\$_{ingred}$ in thousand dollars

$\$_{manu}$ = costs of manufacturing in thousand dollars

U_{manu} = disturbance for predicting $\$_{manu}$ in thousand dollars

$\$_{admin}$ = costs of administration and selling in thousand dollars

U_{admin} = disturbance for predicting $\$_{admin}$ in thousand dollars

$\$_{costs}$ = total cost in thousand dollars

ASP = sales promotion per pound of bread

AR = revenue per pound of bread

π = profit per pound of bread

π_{ind} = the market's profit per pound of bread

APPENDIX B

Types of Representative Baking Firms

The NCFM data (27) are used to estimate decision parameters for the n-firms in the market. The data represent cross section replications of several types of wholesale baking firms operating in different situations of bilateral oligopoly. It is based on the assumptions that there is no intermarket activity and that intramarket activity is similar from one market to another. This formulation contrasts with studies of perfect competition which have considered such information as replications of a single representative firms. Separation of specific kinds of firms is based on an assumption that firms with particular structural and performance characteristics behave in similar patterns. The problem is to determine the number of specific kinds of firms as well as the characteristics which differentiate them. In the following sections, types of characteristics which may differentiate firms are defined, methods of grouping firms with similar structural and performance characteristics are explored, and the number and characteristics of firms used in the model are presented.

Firms' characteristics.--One type of structural characteristic is the form of business operation: independent, cooperative, or multi-state corporation. Size of firm--small, medium, and large--may indicate different degrees of market power. Degree of plant utilization, degree of product diversification, techniques of flour handling, and types of production processes may affect efficiency and thereby indicate something about a firm's aggressiveness.[50/] Types of bread

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50/ There would be no effect on aggressiveness if the firm were purely a profit maximizer. But if it has such goals as improving the market share, then factors which affect efficiency may also affect behavior.

labeling, types of distribution outlets, and types of advertising are additional structural dimensions which may indicate differing behavioral patterns. Similarly, a firm's share of the market, profit per pound of bread, return on equity, and return on sales may be some of the performance characteristics which alter behavioral patterns.

Methods of grouping homogeneous wholesale baking firms.--One way to determine homogeneous groups of wholesale baking firms is the technique of cluster analysis (40). In this type of sophisticated analysis, the null hypothesis states that there is no relationship between a firm's structural and performance characteristics and its behavior. These characteristics must be quantified and a matrix of "similarity coefficients" derived between all pairs of firms. "Cluster indices" (similarity coefficients) are entered into a computer program which develops a binary tree showing the clustering of firms at various iterations. The clustering continues until there is only one cluster in which all firms belong to the same group. The level of clustering desired is chosen arbitrarily. This level defines the number of representative firms and their characteristics.

Although this type of analysis may be a logical way to develop homogeneous groups of firms, it is difficult to derive similarity coefficients. For example, an infinite number of correlation matrices of the characteristics can be derived if the latter are assigned an infinite number of weighting patterns. Alternatively, an infinite number of matrices showing the Euclidean distance between the firm's characteristics can be derived. This procedure for clustering firms with homogeneous behavioral patterns would be a study in itself. Consequently, it was not justified in light of our objectives.

A simpler procedure considers only a few structural characteristics affecting firm behavior. The characteristics used in this analysis were form of

business operation and size of firm.[51/] They were considered to affect behavioral parameters of decision subsystems. Since the distribution subsystem is of primary interest in this study and since driver-salesperson wholesale is the major distribution outlet, a preliminary analysis was made for this outlet to determine the effects of these two structural characteristics on firm behavior. Such an analysis yields the number and characteristics of representative wholesale baking firms to include in the model.

Analysis determining number and characteristics of representative firms.--The functional form of the estimated equations is linear when the formulation is based on equation 5.1. Coefficients representing behavior under the most restrictive situation (hypothesis A), stating that there is no relationship between a firm's structural characteristics and its parameters of behavior, were estimated as a pooled regression (all firms in appendix table B.1).

Three alternative situations are tested. In hypothesis B, the form of business operation has an effect on the parameters of firm behavior. In hypothesis C, size of firm has an effect on the parameters of firm behavior. And in hypothesis D, the form of business operation in conjunction with size of firm has an effect on the parameters of firm behavior. Coefficients representing behavior under the first two alternative hypotheses were estimated as individual regressions separating effects by form of business operation and size of firm.[52/] Independent

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51/ The NCFM (27) supported this selection because it summarized the wholesale bakery data on that basis.

52/ Small firms had an 80-hour weekly capacity of less than 250,000 pounds of bread, medium firms had from 250,000 to 500,000 pounds, and large firms had over 500,000 pounds.

firms were grouped with cooperative firms because lack of sufficient data on independents precluded estimating an equation for them separately. Coefficients of behavior under the third alternative hypothesis were estimated in several regressions which showed cross effects because of form of business operation and size of firm. The results are not reported, and reasons for omitting them will become apparent shortly.

All parameter values in appendix table B.1 have the expected signs regardless of level or type of aggregation, and the percentage of error explained in each regression is uniformly high. An F-test was used to determine whether the behavioral coefficients were constant over form of business operation and size of firm.[53/] This statistic shows that hypothesis A should be rejected when tested against hypothesis B, for example, on the basis of form of business operation when F=5.39 and is significant at the 0.05 level. It should also be rejected when it is tested against hypothesis C, for example, on the basis of size of firm when F=9.02 and is significant at the 0.05 level.

Additional analysis showed that hypothesis B should be rejected when tested against hypothesis C. For example, the behavioral patterns affected by size of firm are significantly different from those affected by type of business operation when F=13.6 and is significant at the 0.05 level. However, hypothesis C could not be rejected when tested against hypothesis D. For example, there is little difference between behavioral patterns affected by size of firm in conjunction with type of business operation and those affected by size of firm alone when F=1.44 and is insignificant at the 0.05 level. For this reason, the model of the baking markets includes three representative wholesale baking firms--small, medium, and large.

53/ Chow (6) showed that the measure employed here is a ratio of two independent Chi-square variables, each divided by their respective degrees of freedom.

Appendix table B.1—Statistical analysis of quantities distributed via driver-salesperson wholesale for determining number and characteristics of representative wholesale baking firms

Firm type	Q_1 2/	N	Q"	Q_{p1}	$\frac{\pi_{dsws}}{\pi_{all}}$	$\frac{\pi_{dshs}}{\pi_{all}}$	$\frac{\pi_{drop}}{\pi_{all}}$	$\frac{\pi_{dock}}{\pi_{all}}$	σ^2	R^2	F	$S_{\hat{y}}$
			Coefficients for 1/ --									
All firms	16.84 (13.20)	460	0.849* (0.015)	-0.256* (0.098)	3.44* (0.39)	-5.68* (0.86)	-0.92* (0.38)	-1.98* (0.41)	-0.073* (0.015)	0.890		4.40
Independent and cooperative	12.10 (8.59)	156	0.817* (0.031)	-0.261* (0.109)	3.74* (0.54)	-2.42* (0.78)	-1.84* (0.51)	-1.82* (0.57)	-0.045 (0.015)	0.866	5.390	3.21
Multistate corporation	19.27 (14.44)	304	0.867* (0.018)	-0.178 (0.151)	3.28* (0.50)	-12.26* (1.61)	0.01 (0.51)	-2.53* (0.53)	-0.105* (0.025)	0.897		4.68
Small	8.05 (6.22)	113	0.915 (0.025)	-0.038 (0.136)	0.96* (0.29)	-1.39* (0.59)	-0.31 (0.30)	-2.00* (0.31)	-0.006 (0.012)	0.939		1.58
Medium	15.08 (7.86)	245	0.878* (0.020)	-0.312* (0.074)	2.98* (0.37)	-3.60* (0.71)	-0.87* (0.31)	-2.73* (0.32)	-0.054* (0.011)	0.900	0.902	2.51
Large	30.82 (17.55)	102	0.814* (0.040)	-0.179 (0.287)	10.07* (2.07)	-16.20* (2.94)	-3.19* (1.37)	-3.59* (1.52)	-0.446* (0.092)	0.853		

a/ Coefficients significantly different from zero at the 5 percent level are denoted by * and at the 10 percent level by **. Standard errors of the estimates are in parentheses.

b/ Mean values of the dependent variables are reported in million pounds per year. Standard errors are in parentheses.